

AU-A125 363 SOLAR OBSERVATIONS DURING SKYLAB APRIL 1973-FEBRUARY
 1974 I CORONAL X-RAY. (U) JOHNS HOPKINS UNIV LAUREL MD
 APPLIED PHYSICS LAB J-Y HANSON ET AL FEB 83
 UNCLASSIFIED AFGL-TR-83-0049 NIPR-F71218100001 F/G 3/2

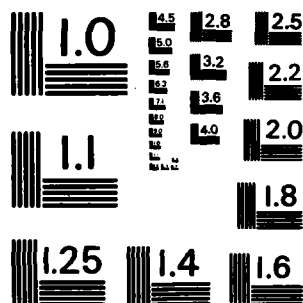
SOLAR OBSERVATIONS DURING SKYLAB APRIL 1973-FEBRUARY
1974 1 CORONAL X-RAY..(U) JOHNS HOPKINS UNIV LAUREL MD
APPLIED PHYSICS LAB J M HANSON ET AL. FEB 83
AFGL-TR-83-0049 MIPR-FY7121810001 F/G 3/2

11

F/G 3/2

NL.

END
DATE
FILED
A 8
BUL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

REPORT UAG-79

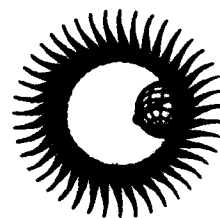
AD A 125 363

AFGL-TR-83-0049

WORLD DATA CENTER A for Solar-Terrestrial Physics



**SOLAR OBSERVATIONS DURING SKYLAB
APRIL 1973-FEBRUARY 1974
I. CORONAL X-RAY STRUCTURE
II. SOLAR FLARE ACTIVITY**



December 1980

88 08 04 080

WORLD DATA CENTER A
National Academy of Sciences
2101 Constitution Avenue, N.W.
Washington, D.C., U.S.A., 20418

World Data Center A consists of the Coordination Office

and seven Subcenters:

World Data Center A
Coordination Office
National Academy of Sciences
2101 Constitution Avenue, N.W.
Washington, D.C., U.S.A., 20418
[Telephone: (202) 389-6478]

Glaciology [Snow and Ice]:

World Data Center A: Glaciology
[Snow and Ice]
Inst. of Arctic & Alpine Research
University of Colorado
Boulder, Colorado, U.S.A. 80309
[Telephone: (303) 492-5171]

Meteorology (and Nuclear Radiation):

World Data Center A: Meteorology
National Climatic Center
Federal Building
Asheville, North Carolina, U.S.A. 28801
[Telephone: (704) 258-2850]

Oceanography:

World Data Center A: Oceanography
National Oceanic and Atmospheric
Administration
Washington, D.C., U.S.A. 20235
[Telephone: (202) 634-7249]

Rockets and Satellites:

World Data Center A: Rockets and
Satellites
Goddard Space Flight Center
Code 601
Greenbelt, Maryland, U.S.A. 20771
[Telephone: (301) 344-6695]

Rotation of the Earth:

World Data Center A: Rotation
of the Earth
U.S. Naval Observatory
Washington, D.C., U.S.A. 20390
[Telephone: (202) 254-4023]

Solar-Terrestrial Physics (Solar and
Interplanetary Phenomena, Ionospheric
Phenomena, Flare-Associated Events,
Geomagnetic Variations, Magnetospheric
and Interplanetary Magnetic Phenomena,
Aurora, Cosmic Rays, Airglow):

World Data Center A
for Solar-Terrestrial Physics
Environmental Data and Information
Service, NOAA
Boulder, Colorado, U.S.A. 80303
[Telephone: (303) 497-6323]

Solid-Earth Geophysics (Seismology,
Tsunamis, Gravimetry, Earth Tides,
Recent Movements of the Earth's
Crust, Magnetic Measurements,
Paleomagnetism and Archeomagnetism,
Volcanology, Geothermics):

World Data Center A
for Solid-Earth Geophysics
Environmental Data and Information
Service, NOAA
Boulder, Colorado, U.S.A. 80303
[Telephone: (303) 497-6321]

NOTES:

1. World Data Centers conduct international exchange of geophysical observations in accordance with the principles set forth by the International Council of Scientific Unions. WDC-A is established in the United States under the auspices of the National Academy of Sciences.
2. Communications regarding data interchange matters in general and World Data Center A as a whole should be addressed to: World Data Center A, Coordination Office (see address above).
3. Inquiries and communications concerning data in specific disciplines should be addressed to the appropriate subcenter listed above.

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DC 25 Feb 83

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER AFGL-TR-83-0049	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER (2)
4. TITLE (and Subtitle) SOLAR OBSERVATIONS DURING SKYLAB APRIL 1973- FEBRUARY 1974. I. CORONAL X-RAY STRUCTURE. II. SOLAR FLARE ACTIVITY.		5. TYPE OF REPORT & PERIOD COVERED Reprint
7. AUTHOR(s) J.M. Hanson* E.C. Roelof and R.E. Gold		8. CONTRACT OR GRANT NUMBER(s) MIPR FY71218100001
9. PERFORMING ORGANIZATION NAME AND ADDRESS The Johns Hopkins University Applied Physics Laboratory Laurel, MD 20707		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 61102F, 2311, 2311G1, 2311G1A1
11. CONTROLLING OFFICE NAME AND ADDRESS Air Force Geophysics Laboratory Hanscom AFB, MA 01731 Monitor/M. A. Shea/PHG		12. REPORT DATE February 1983
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		13. NUMBER OF PAGES 43
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited		15. SECURITY CLASS. (of this report) Unclassified
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
18. SUPPLEMENTARY NOTES Work performed as task ZF10 of Contract N0024-78-C-5384, Dept. of the the Navy. Continues work previously performed under MIPR FY71217900011 and FY71218000003. *Dept. of Aeronautical Engineering, Univ. of Michigan, Ann Arbor, MI. published as UAG-79 Report, WDC A for Solar-Terrestrial Physics, NOAA, Boulder, CO. 80303		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) solar physics solar flares solar corona Skylab (approx. 10 deg) H-alpha Original contains color plates: All DTIC reproductions will be in black and white.		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Large-scale (~10') emission features visible in soft x-ray photographs from the American Science and Engineering, Inc. (AS&E) spectrographic telescope S-054 on Skylab have been superposed on He Synoptic Charts (McIntosh, 1975) for Carrington Rotations 1601 through 1610. The charts identify loop arcades and loop complexes associated with strong magnetic fields, as well as coronal holes and areas devoid of emission loops. Although not adequate for the study of the geometry of individual features, the charts convey a global sense of coronal structure which is often difficult to obtain from individual (disk) images. ←		

DTIC
ELECTE
MAR 7 1983
A

AD A1 25363

DTIC FILE COPY

DD FORM 1 JAN 73 1473

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

WORLD DATA CENTER A for Solar-Terrestrial Physics



REPORT UAG-79

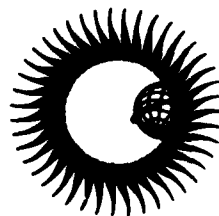
SOLAR OBSERVATIONS DURING SKYLAB APRIL 1973-FEBRUARY 1974 I. CORONAL X-RAY STRUCTURE II. SOLAR FLARE ACTIVITY

by

J.M. Hanson
Department of Aeronautical Engineering, University of Michigan
Ann Arbor, Michigan

E.C. Roelof and R.E. Gold
Applied Physics Laboratory, The Johns Hopkins University
Silver Spring, Maryland

December 1980



Published by World Data Center A for
Solar-Terrestrial Physics, NOAA, Boulder, Colorado
and printed by

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
ENVIRONMENTAL DATA AND INFORMATION SERVICE
Boulder, Colorado, USA 80303

SUBSCRIPTION PRICE: \$25.00 per year; \$17.50 additional for foreign mailing; single copy price varies.*
Checks and money orders should be made payable to the Department of Commerce, NOAA/NGSDC.
Requests and correspondence regarding subscriptions should be sent to the National Geophysical and
Terrestrial Data Center, NOAA, Boulder, CO 80303.

CONTENTS

	Page
I. CORONAL X-RAY STRUCTURE	1
Abstract	1
1. Introduction	1
2. Synoptic Charts of X-ray Features from the Soft X-ray Photographs Taken by the Skylab Experiment S-054 (American Science and Engineering, Inc.)	1
Acknowledgments	5
II. SOLAR FLARE ACTIVITY	5
Abstract	5
1. Introduction	5
2. Procedure for Drawing Solar Activity Charts	5
Acknowledgments	6
REFERENCES	6
APPENDIX A: H α Synoptic Charts, Rotations 1601-1610	9
APPENDIX B: Solar Activity Charts, Rotations 1600-1611	31



Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
Dist	Special

A

SOLAR OBSERVATIONS DURING SKYLAB

APRIL 1973 - FEBRUARY 1974

I. CORONAL X-RAY STRUCTURE

II. SOLAR FLARE ACTIVITY

by

J. M. Hanson

Department of Aeronautical Engineering, University of Michigan
Ann Arbor, Michigan

E. C. Roelof and R. E. Gold

Applied Physics Laboratory, The Johns Hopkins University
Silver Spring, Maryland

I. CORONAL X-RAY STRUCTURE

ABSTRACT

Large-scale ($\sim 10^\circ$) emission features visible in soft X-ray photographs from the American Science and Engineering, Inc. (AS&E) spectrographic telescope S-054 on Skylab have been superposed on H α Synoptic Charts [McIntosh, 1976] for Carrington Rotations 1601 through 1610. The charts identify loop arcades and loop complexes associated with strong magnetic fields, as well as coronal holes and areas devoid of emission loops. Although not adequate for the study of the geometry of individual features, the charts convey a global sense of coronal structure which is often difficult to obtain from individual (disk) images.

1. INTRODUCTION

The interest of our group at the Johns Hopkins University/Applied Physics Laboratory in the American Science and Engineering, Inc. soft X-ray images of the solar corona began with the first association of a solar wind stream with a coronal hole photographed on a rocket flight in 1970 [Krieger et al., 1973]. Later, the AS&E Skylab data from the S-054 X-ray spectrographic telescope allowed us to extend the associations between coronal X-ray structure and solar wind streams [Krieger et al., 1976; Molte et al., 1976a, Mitchell et al., 1980] and to include energetic particles from 300 keV to > 3 GeV [Gold et al., 1976a, b; Roelof et al., 1976a, b; Roelof, 1976]. These studies related interplanetary observations to large-scale X-ray features, e.g., coronal holes or large complexes of loop-like structures. We decided that the next logical step was to make more detailed comparison with the loop-like structures which spanned 5° or more of heliographic longitude or latitude.

We have therefore prepared an atlas of X-ray features from the S-054 Skylab data covering Carrington Rotations 1601 - 1610 (May 29, 1973 to January 31, 1974). In order to facilitate comparison with other Skylab data, we have mapped the X-ray features onto synoptic charts in heliographic longitude and latitude which overlay the H α Synoptic Charts of McIntosh [1976]. We caution the user that, since we were initially interested in coarse ($\sim 10^\circ$) structure, we worked from positive prints made from 70-mm negatives available from the National Space Science Data Center. These are of significantly lower quality than that available from AS&E internegatives, as we document below. Even though individual loop locations and configurations cannot be considered exact, we intend to use these X-ray synoptic charts as indicators of the general characteristics of regions of about $20^\circ \times 20^\circ$ in area. In other words, these charts can adequately identify loop arcades, loop complexes associated with strong fields, and areas devoid of emission loops, but they are inadequate for any study of the geometry of individual loops. We regard their main utility to be in conveying a global sense of coronal organization which is difficult to gain from individual (disk) images. These charts are in Appendix A.

2. SYNOPTIC CHARTS OF X-RAY FEATURES FROM THE SOFT X-RAY PHOTOGRAPHS TAKEN BY THE SKYLAB EXPERIMENT S-054 (AMERICAN SCIENCE AND ENGINEERING, INC.)

The basic data set was the 70-mm microfilm, (National Space Science Data Center, No. 73-027A-0513), from which $8'' \times 10''$ glossy prints were made at two different exposures. These photographs covered Carrington Rotations 1601 - 1608, and those used are listed in Table 1 by numbers between 1 and 163. On rotations 1609 - 1610, the S-054 images were partially obscured by a defective filter wheel, but usable images were provided on $8'' \times 10''$ negatives by J. T. Molte of AS&E. The out-of-focus image of the deformed filter wheel was clearly identifiable and seriously affected only a portion of the image. Contact prints were made of these negatives, and those used are listed by a 5-digit number in Table 1. A "montage" of the useful portions of the X-ray images from rotations 1609 and 1610 was published by Mitchell et al. [1980].

In order to use the photographs, the north and south poles of the Sun had to be located in each photograph. The roll angle (γ_{roll}) for the time when each picture was taken was found in the "Skylab X-Ray Telescope Film Image Catalog" provided by NSSDC with the documentation of the microfilm. Using a transparent overlay on the photographs, the poles were easy to locate. By centering the solar disk and aligning the lines with fiducial marks on the left side of the photographs, γ_{roll} located the north pole. In some photographs, fiducial marks did not exist on the left side. In this case the marks on the right side were aligned with the result that γ_{roll} gave the south pole of the Sun.

From the time of the day when the picture was taken, the heliographic longitude of central meridian could be calculated. These longitudes are listed (by photograph number) in Table 1. Stonyhurst Sun disks (transparent overlays) for integer values of the inclination (B_0) of the solar equator were laid over the photograph and the latitudes and longitudes read directly.

For each area of the Sun during rotations 1601 - 1608, photographs were examined and those in which the region of interest was most clearly shown were chosen. This choice generally included two or three photographs taken before and two or three taken after the main photograph. The different photographs made it possible to view the area of interest in the corona from many different angles. Viewing different photographs made it possible to discern what three-dimensional loops existed and to pick out many that were not visible in the central photograph. Only the central photographs are listed in Table 1.

TABLE 1

PRINCIPAL X-RAY PHOTOGRAPHS USED FOR CHARTS

Photo No.	Carrington Rotation	Heliolongitude of CM (deg)	Time of Photo (day:hr:min)
1	1601	46	149:07:06
5	1602	352	153:07:59
7	1602	263	160:01:21
11	1602	210	164:01:20
17	1602	120	170:20:41
20	1602	85	173:12:32
24	1602	32	177:13:00
28	1603	339	181:11:42
33	1603	272	186:13:16
38	1603	206	191:12:53
44	1603	128	197:18:06
46	1604	314	209:16:44
52	1604	239	216:06:47
56	1604	176	221:01:10
63	1604	77	228:13:33
73	1605	312	238:00:39
81	1605	206	246:01:12
91	1605	73	256:02:00
97	1606	353	262:03:11
99	1606	327	264:03:20
101	1606	288	267:01:10
105	1606	235	271:01:29
106	1606	222	272:00:44
115	1606	104	281:00:32
116	1606	90	282:01:25
120	1606	37	286:01:53
125	1607	332	291:01:26
127	1607	298	293:14:06
136	1607	186	302:01:40
144	1607	81	310:02:12
149	1607	15	315:01:53
153	1608	303	320:12:14
155	1608	262	323:14:46
163	1608	164	331:01:43
050048	1609	140	360:05:23
051039	1609	96	363:13:41
051544	1609	17	4:12:37
052095	1610	285	11:14:03
053275	1610	207	17:14:39
054996	1610	154	21:12:08
056362	1610	75	27:14:12
056542	1610	22	31:13:05

During rotations 1609 and 1610, the out-of-focus image of a bent filter wheel caused part of each photograph to be obscured. For this reason, the procedure was modified slightly. Starting with the earliest chosen photograph, loops seen on each photograph were extracted. These loops were checked with the other photographs. The photographs were studied in the order of when they were taken.

For the entire period, the loops chosen were those in which both footpoints could be seen. When both footpoints were apparent, they were located by dots and connected with a dashed line. If both footpoints could not be determined accurately, the minimum observed extent of the loop was shown by a dotted line. This was done so that at least an idea of the structure involved could be obtained (e.g., Rotation 1609).

After the loops were picked out, they were traced on transparent acetate which was placed over the central photograph. If the loops could be seen on the central photograph, they were drawn directly on the acetate. If not, the Stonyhurst disks made it possible to find the latitudes and longitudes involved on adjacent images and to relocate the loops on the drawing. In this manner, as many loops as possible were extracted from within 60° of the sub-terrestrial point in the central photograph.

Using Stonyhurst disks, the footpoints of the loops were transferred from the acetate tracings to the H α Synoptic Charts from the Skylab Atlas by McIntosh [1976]. They were marked by dots and connected by lines to show what loops exist. Again, if the exact locations of the footpoints are in question, the loops were indicated by dotted lines. Certain areas of rotations 1603, 1608, and 1609 contain no data because of gaps in the X-ray photographs.

Many possibilities for error exist in determining the loops. The error in locating the north and south poles was less than $1/2$ degree and was considered insignificant. The error in determining the longitude was at most $1/10$ degree for rotations 1601 - 1608 and $1/2$ degree for 1609 - 1610. The error from approximating B_0 is less than $1/2$ degree for rotations 1601 - 1608, and less than one degree for 1609 - 1610. These errors are small and random in nature. There are larger possibilities for error. Near central meridian, the error for locating footpoints which can be seen is less than two degrees. Near the limb, however, the cosine projection effect translates a small error in locating a loop into an error as large as five degrees in longitude near the limb, although latitude is unaffected. Such near-limb images were used only as a last resort due to missing data.

There are also many subjective factors in defining the X-ray structures. Four examples of configurations which could be misinterpreted are shown in Figure 1A, and the resulting drawings in Figure 1B. The chances of these misinterpretations were minimized by using many photographs for the same region. This enabled the structures to be viewed from different angles, reducing the chances for error. In example (i) of Figure 1, two small loops, if unresolved, may be drawn as a single larger loop. On the other hand, a long loop (example ii) whose top is not visible in emission may be drawn as two shorter loops. Example (iii) is a dark X-ray filament channel which sometimes overlies a large H α filament. Since high-lying loops are often faint, continuity could be suggested and the full loops drawn, or conversely, the dark gap could be discernible with the same result as example (ii). Finally, if there are loops near high latitudes which extend over the limb but are not fully illuminated (example iv), only their lower segments may appear in the drawing.

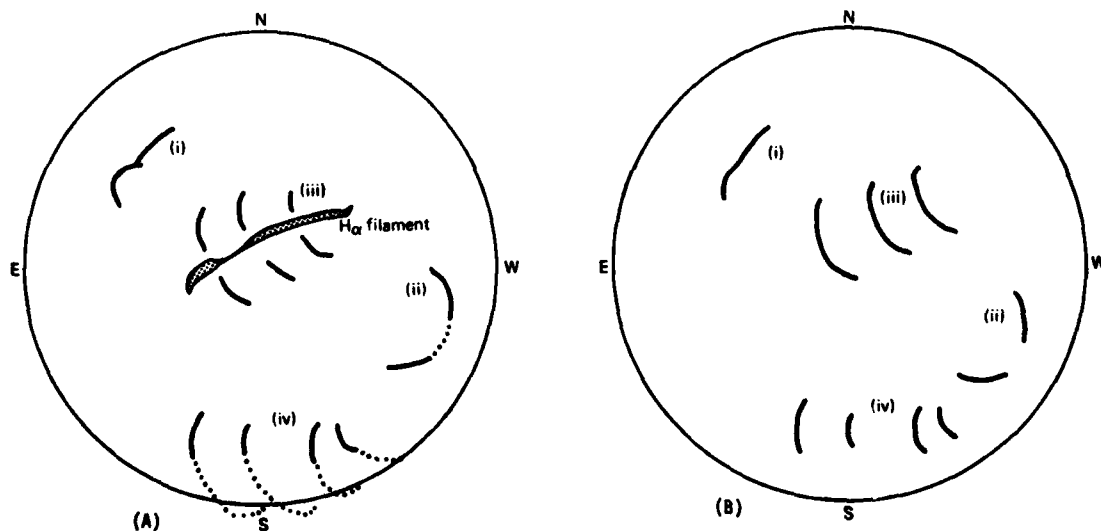


Fig. 1. (A) shows four X-ray structures likely to be misinterpreted. (B) shows the resulting drawings. In (i) two unresolved loops were combined; in (ii) the top of a loop is unseen and is drawn as two loops; in (iii) a dark X-ray channel is interpreted as three complete loops; in (iv) unit parts of a loop on the limb are missed.

In addition, there will be one rather obvious situation where no loops will appear on the charts, although they are likely to be present on the Sun. On the 64-second exposure negatives used for this study (NSSDC-73-027A-OSC/D), active region X-ray plages (which often overlie H α plages) are strongly over-exposed. Therefore, end points of loops leading into plages were not identifiable, nor were loops lying completely within large plages. Consequently these charts depict only large-scale loops with at least one footpoint well away from bright X-ray plage regions.

An independent problem was that in many cases there was evolution of the loop structure from day-to-day. The result of this is that specific loops have to be chosen on a given photograph, while a day later the structure may appear different on another photograph. This was especially apparent for parts of rotations 1609 and 1610.

The result of all these inherent and subjective errors is that the results must be viewed as approximate. This fact can be easily seen if one compares drawings showing photographs 105 and 106 at central meridian as shown in Figure 2. The difference in central meridian is 12.8° . There are many similarities, but also many differences, even though the photographs were taken only one day apart.

The photographs were fourth-generation prints. For photograph #63 and adjacent photographs, second-generation prints were obtained from American Science and Engineering, Inc. As can be seen from Figure 3, which compares the drawing made from (A) NSSDC 70-mm microfilm #63 with the drawing made from (B) AS&E $8'' \times 10''$ second-generation negatives, the loop structure seen is more complex in the higher quality prints than in those used to make these charts. However, the large scale structure is similar, and this was our main objective.

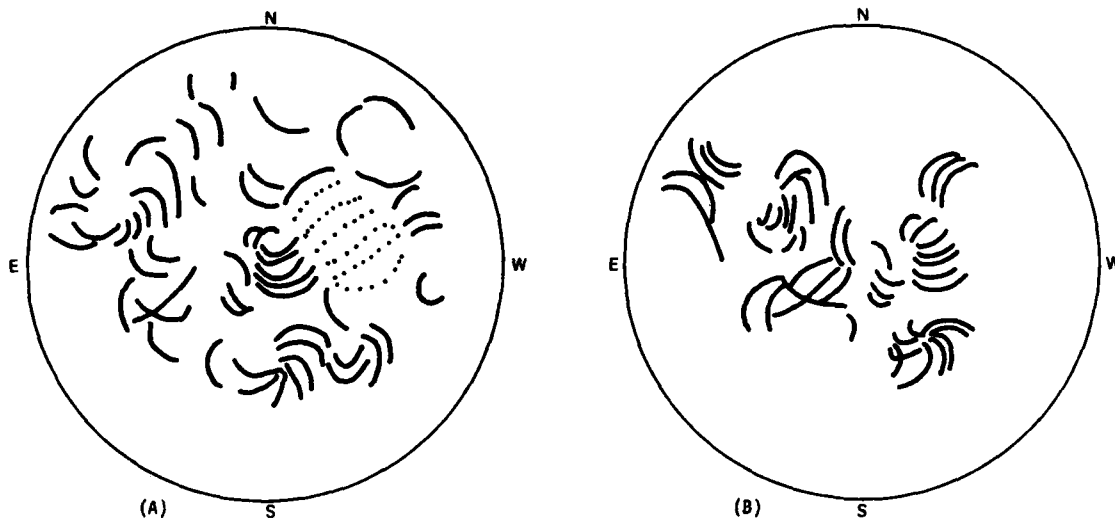


Fig. 2. Drawings of photograph 105, in (A), and 106, in (B), are compared. They have central meridians of $L=235.3^\circ$ and $L=222.5^\circ$ respectively. Though taken only one day apart, the interpretations are different.

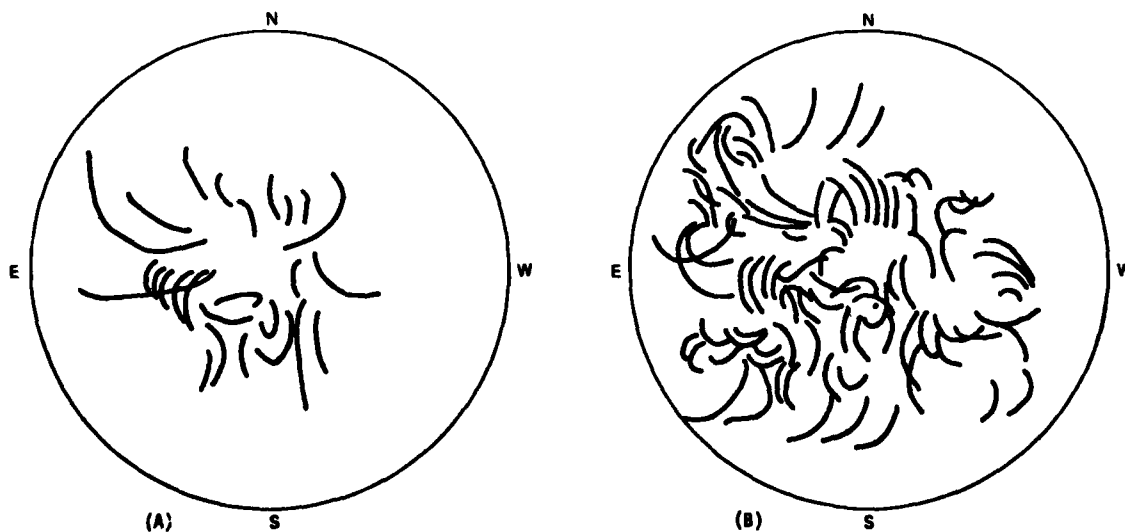


Fig. 3. Drawings of X-ray structures made from NSSDC 70-mm microfilm #63, (A), and an $8'' \times 10''$ second-generation negative of the same region, (B), show that although (A) shows fewer details, the large scale patterns are similar.

The X-ray structures, as drawn on a rectangular heliographic latitude and longitude grid, are printed in color and overlaid on the H α Synoptic Charts. When both loop footpoints were apparent, they were located by dots and connected with a dashed line. If both footpoints could not be determined accurately, the minimum observed extent of the loop was shown by a dotted line (as on rotation 1609).

The image resolution on rotation 1610 was also low, but for clarity, the loop connections are shown simply as dashed lines. The strongly over-exposed images of X-ray plages (where no loops can be resolved) are indicated by regions diagonally striped in color. The regions stippled in color are the coronal holes CH 1 through CH 6, taken from Holte *et al.*, [1976b]. Boundaries for coronal holes not covered by that publication were taken from Bohlén and Rubenstein, [1976]. Areas not covered by either publication show no boundary data. The boundary of one particularly extensive hole, extending from the south pole up past the equator in the eastern hemisphere on rotation 1610 was estimated by Mitchell *et al.* [1980] from the same soft X-ray photographs listed in Table 1 and is shown on the chart.

All-in-all, we believe that if the Synoptic Charts of X-ray features are regarded as what the eye perceives in the X-ray photographs (and therefore as indicative only of the approximate location and nature of the actual emission features), they will be useful as a representation of large-scale coronal structures. The synoptic charts should be considered as preliminary, but sufficiently accurate for use as they stand, within the guidelines set down in the Introduction. *Note added in proof:* Final cross-checking of the printed charts revealed two regions of systematic misalignment, aside from isolated minor plotting errors (the great majority of which were less than 2° in position). On rotation 1605, all footpoints west of 310° should be shifted 2° toward the east, and on rotation 1608, all footpoints between 120° and 350° should be shifted 2° to the west. These misalignments are noted on the two charts.

ACKNOWLEDGMENTS

These charts constituted part of a senior thesis presented by JMH to the Department of Physics and Engineering of Loyola College (Baltimore). Full-sized originals of the H α Synoptic Charts were provided by P. S. McIntosh of the Space Environment Laboratory, NOAA/ERL. We appreciate the helpful comments of A. S. Krieger and J. T. Molte of American Science and Engineering, Inc. who also provided unpublished negatives to complement the National Space Science Data Center 70-mm film record. Work at JHU/APL was supported by the National Aeronautics and Space Administration under Grant NSG-7077 and by the Air Force Geophysics Laboratory via Task ZF10 of Contract N00024-78-C-5384 with the Department of the Navy.

II. SOLAR FLARE ACTIVITY

ABSTRACT

Charts of time versus longitude for each of Carrington Rotations 1600 - 1611 depict: 1) H α importance, brightness, and location of confirmed flares; 2) peak flare X-ray flux 1-8 Å; 3) peak flare decimetric radio intensity; and 4) flux of 1.8 - 4.5 MeV protons plotted at their high coronal emission longitude estimated from simultaneously measured solar wind velocity.

1. INTRODUCTION

These Solar Activity Charts are a compilation for the Skylab period of selected indices of optical solar flares, radio bursts, soft X-rays, and energetic particles in a concise form. The charts were initially designed to complement studies of the coronal and interplanetary distribution of energetic solar particle populations, although their compact representation of spatial and temporal relationships has been of assistance in a wide variety of solar-terrestrial studies. The charts show the H α importance and brightness of confirmed flares, the 1-8 Å peak X-ray flux and a spectral average of decimetric radio emissions related to the optical flares. Full disk coverage extends from April 13, 1973 through February 24, 1974. See Appendix B.

The energetic particle fluxes are represented on the charts as a continuous swath centered on the estimated high coronal connection longitude of the large scale interplanetary field line from Earth. The width of the swath is proportional to the logarithm of the ~ 3 MeV proton flux measured at Earth. The charts are organized in heliographic longitude versus time so it is easy to follow the development of an active region throughout its disk passage on a given solar rotation as well as its recurrences over several rotations, since all the activity from a given region falls on a straight vertical line. Conversely, all the flares and related radio and X-ray bursts on the disk at a given time are distributed along a horizontal line. The charts also indicate directly the distance between an active region and the longitude where energetic protons (associated with activity in that region) were injected onto the interplanetary field lines leading to the Earth.

2. PROCEDURE FOR DRAWING SOLAR ACTIVITY CHARTS

On the Solar Activity Charts for Carrington Rotations 1600 - 1611, time is measured on the vertical axis and heliographic longitude on the horizontal axis. Time progresses upward and is measured in day of year on the left and day of month on the right. Thus the locus of each limb progresses from lower right to upper left. The format follows that introduced by Old *et al.* [1974].

The data on the activity charts are accurate to approximately one degree and to two hours. The confirmed visible flares, their X-ray data and their radio data were all found in *Solar-Geophysical Data (Comprehensive Reports)*. The importance of the H_z flares is shown by the size of the circle. Bright flares are solid, while normal and faint ones are open. The flares shown range in importance from importance (-) to importance 3. If more than one flare occurred in the same active region within a two-hour interval, only the flare of highest importance was plotted.

The number of the McMath Plage Region (MPR) containing the activity is indicated along the bottom of the chart, with northern and southern latitude regions listed on two separate lines. Where more than one MPR occupies the same longitude each additional region is coded with a different non-circular symbol.

The radio burst peak intensities are indicated by diagonal dashes emanating from each flare symbol. The radio data considered were those from the essentially identical instruments at Sagamore Hill (Massachusetts), Manila, the Canary Islands, and Athens. The frequencies used were 1415, 2695, 4995, and 8800 MHz. If the radio data peaked within 10 minutes of the flare's H_z peak, they were considered. The radio flux shown on the activity charts is the average over the four frequencies of the highest flux observed among the four observations at each frequency. The flux is in $W/10^{22} \text{ m}^2 \text{ Hz}$.

The 1-8 Å X-ray fluxes were measured by the Solrad 9 or Solrad 10 spacecraft and reported in *Solar-Geophysical Data*. The peak fluxes are indicated by horizontal or vertical dashes emanating from the flare symbol. They are associated with a given flare if the peak in H_z and X-ray occurs within five minutes. Flux units are $\text{ergs}/10^4 \text{ cm}^2 \text{ s}$. The three X-ray levels on the charts correspond to Boulder classifications M1-M4, M5-X4, and >X5.

The connection longitude of the 1.8-4.5 MeV omnidirectional proton flux is shown on the activity charts. The flux was measured by the JHU/APL energetic particle experiments on the IMP-7 and 8 spacecraft and is indicated at the estimated high coronal "connection longitude". The connection longitude is the estimated source longitude of the interplanetary plasma and "frozen in" interplanetary magnetic field, estimated using observed (1 hr. avg.) solar wind velocities provided by the National Space Science Data Center from the MIT and LASL plasma instruments on the same spacecraft [Nolte and Roelof, 1973]. The flux of the ~3 MeV protons is indicated by the width of the bar centered on the connection longitude path. It is measured to the nearest decade in particles/cm² sr MeV.

ACKNOWLEDGMENTS

We are grateful to J. Leighton and E. Heidgerd of the University of New Hampshire for their assistance in preparing early versions of these charts. The charts, developed into their present form, constituted part of a senior thesis presented by J.M.H. to the Department of Physics and Engineering of Loyola College (Baltimore). Support for this work was provided by the NASA under Grant NSG-7055 and Air Force Geophysics Laboratory under Task ZF10 via Navy Contract N00024-78-C-5384.

REFERENCES

- | | | |
|--|-------|--|
| BOHLIN, J. D. and
D. M. RUBENSTEIN | 1975 | "Synoptic Maps of Solar Coronal Hole Boundaries Derived from He II 304 Å Spectroheliograms from the Manned Skylab Mission," <i>Report UAG-51</i> , (World Data Center A for Solar-Terrestrial Physics, Boulder, Colorado, 80303). |
| GOLD, R.E.,
J.T. NOLTE,
E.C. ROELOF, and
R. REINHARD | 1974 | "The Influence of Coronal Magnetic Structure on Low-Energy Solar Proton Events," <i>Space Research XIV</i> , 477-484. |
| GOLD, R. E.,
E. C. ROELOF,
J. T. NOLTE, and
A. S. KRIEGER | 1975a | "Relation of Large-Scale Coronal X-ray Structure and Cosmic Rays: 5. Solar Wind and Coronal Influence on a Forbush Decrease Lasting One Solar Rotation," <i>Proc. 14th International Cosmic Ray Conference (Munich)</i> , 3, 1095-1100. |
| GOLD, R. E.,
S. M. KRIMIGIS,
E. C. ROELOF,
A. S. KRIEGER, and
J. T. NOLTE | 1975b | "Relation of Large-scale Coronal X-ray Structure and Cosmic Rays: 3. Low-intensity Solar Particle Events with Enhanced ~3 MeV Helium and Medium Fluxes Associated with Solar Wind Streams," <i>Proc. 14th International Cosmic Ray Conference (Munich)</i> , 5, 1710-1715. |
| KRIEGER, A. S.,
A. F. TIMOTHY, and
E. C. ROELOF | 1973 | "A Coronal Hole and its Identification as the Source of a High Velocity Solar Wind Stream," <i>Solar Phys.</i> , 29, 505-525. |
| KRIEGER, A. S.,
J. T. NOLTE,
P. S. MCINTOSH,
A. J. LAZARUS,
J. D. SULLIVAN,
R. E. GOLD, and
E. C. ROELOF | 1975 | "Relation of Large-scale Coronal X-ray Structure and Cosmic Rays: 1. Sources of Solar Wind Streams and H _z Absorption features," <i>Proc. 14th International Cosmic Ray Conference (Munich)</i> , 6, 1698-1703. |

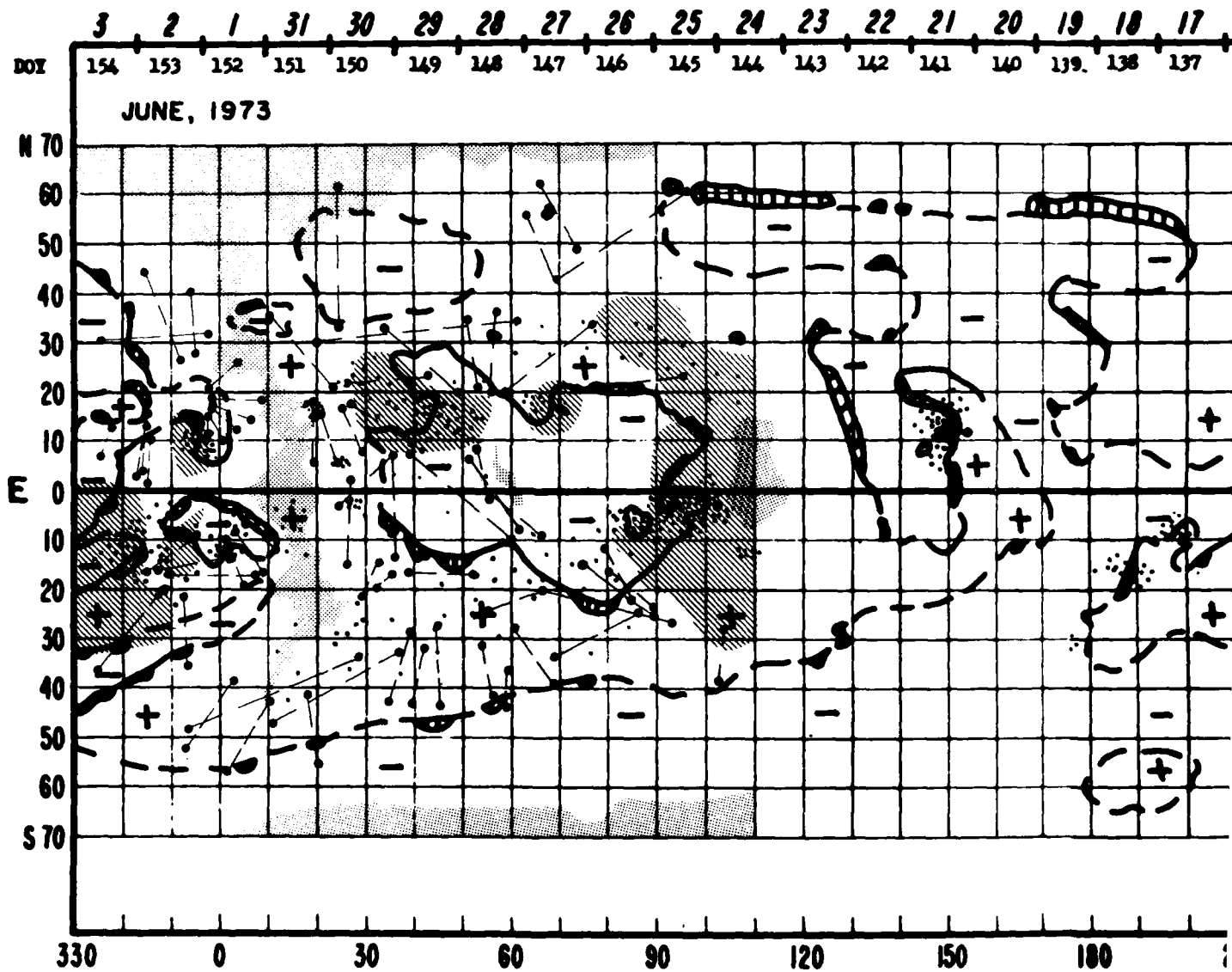
- MCINTOSH, P. S.
- 1975 "H-alpha Synoptic Charts of Solar Activity for the Period of Skylab Observations May 1973 - March 1974, *Report UAG-40*, (World Data Center A for Solar-Terrestrial Physics, Boulder, Colorado, 80303).
- MITCHELL, D. G.,
E. C. ROELOF, and
J. H. WOLFE
- 1980 "Latitude Dependence of Solar Wind Velocity Observed ≥ 1 AU," *J. Geophys. Res.*, **85**, (in press).
- NOLTE, J. T. and
E. C. ROELOF
- 1973 "Large-Scale Structure of the Interplanetary Medium," *Solar Phys.*, **33**, 241-257.
- NOLTE, J. T.,
A. S. KRIEGER,
A. F. TIMOTHY,
R. E. GOLD,
E. C. ROELOF,
G. VAIANA,
A. J. LAZARUS,
J. D. SULLIVAN, and
P. S. MCINTOSH
- 1976a "Coronal Holes as Sources of Solar Wind," *Solar Phys.*, **46**, 303-332.
- NOLTE, J. T.,
A. S. KRIEGER,
A. F. TIMOTHY,
G. S. VAIANA, and
M. V. ZOMBECK
- 1976b "An Atlas of Coronal Hole Boundary Positions, May 28 to November 21, 1973," *Solar Phys.*, **46**, 291-301.
- ROELOF, E. C.
- 1976 "Solar Particle Emission," in *Physics of Solar Planetary Environments, Proc. of the International Symposium on Solar-Terrestrial Physics (Boulder)*, D. J. Williams, Ed. (American Geophysical Union, Washington, D. C.), **1**, 214-231.
- ROELOF, E. C.,
R. E. GOLD,
S. M. KRIMIGIS,
A. S. KRIEGER,
J. T. NOLTE,
P. S. MCINTOSH,
A. J. LAZARUS, and
J. D. SULLIVAN
- 1975a "Relation of Large-scale Coronal X-ray Structure and Cosmic Rays: 2. Coronal Control of Interplanetary Injection of 300 keV Solar Protons," *Proc. 14th International Cosmic Ray Conference (Munich)*, **5**, 1704-1709.
- ROELOF, E. C.,
R. E. GOLD,
A. S. KRIEGER,
J. T. NOLTE, and
D. VENKATESAN
- 1975b "Relation of Large-Scale Coronal X-ray Structure and Cosmic Rays: 4. Amplitude of the Diurnal Variation in Neutron Monitors on Interplanetary Field Lines Originating Above Coronal Holes," *Proc. 14th International Cosmic Ray Conference (Munich)*, **4**, 1138-1143.

APPENDIX A

H_α Synoptic Charts, Rotations 1601-1610

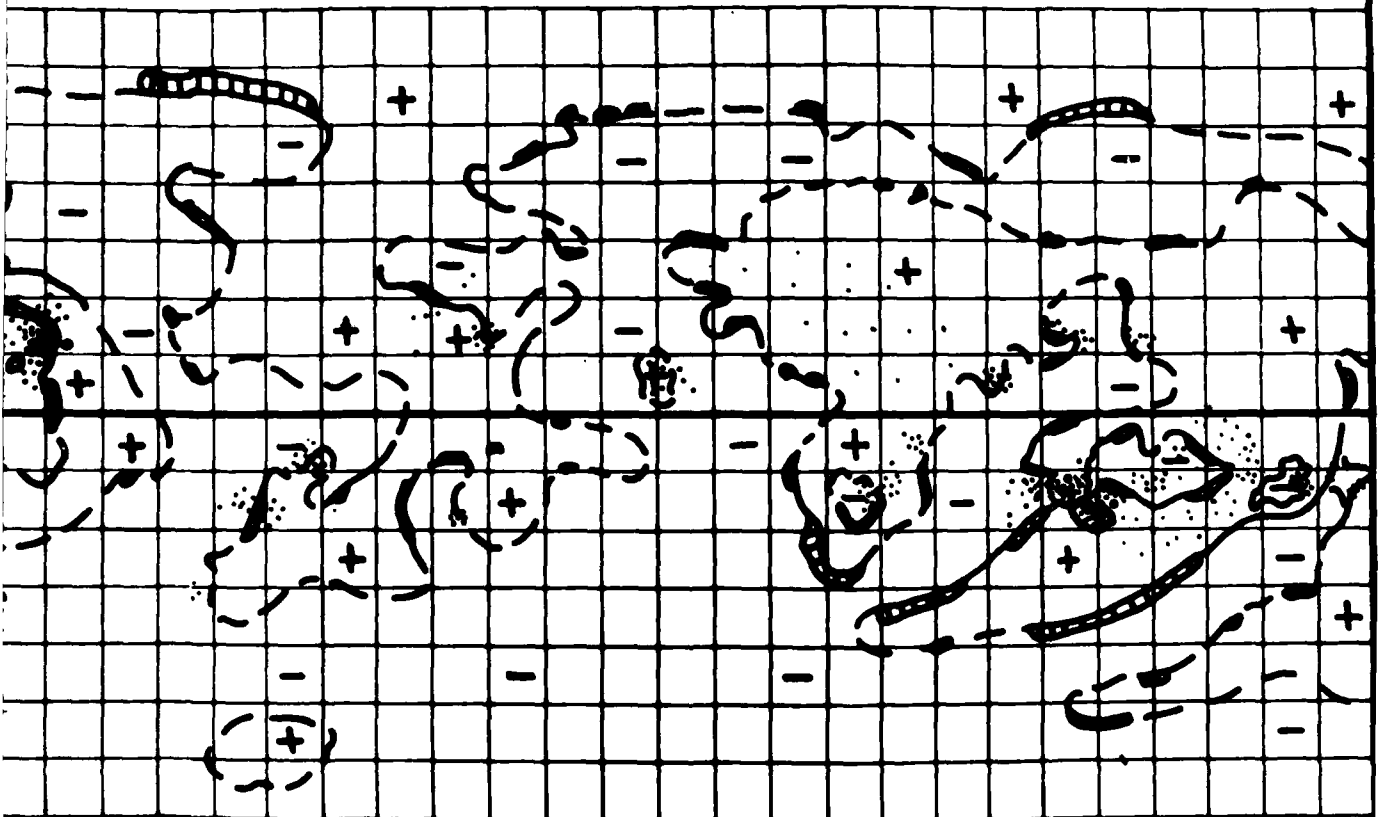
FORWARDED PAGE BLANK-NOT FILMED

H α SYNOPTIC CH. 1973- ROTATION 16



141 140 139 138 137 136 135 134 133 132 131 130 129 128 127 126 125 124 123

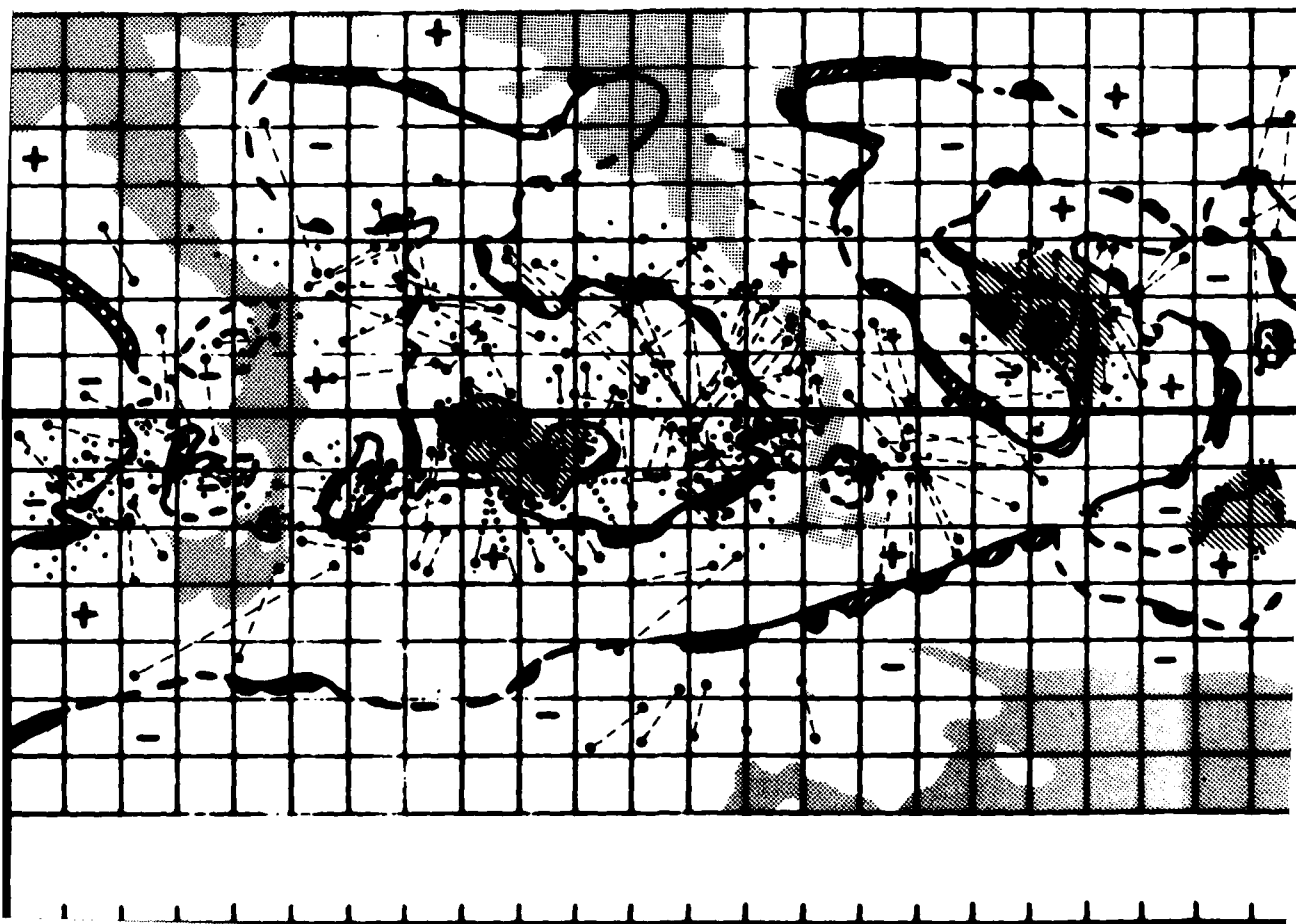
MAY, 1973



11/21/74

181 180 179 178 177 176 175 174 173 172 171 170 169 168 167 166 165

JUNE, 1973



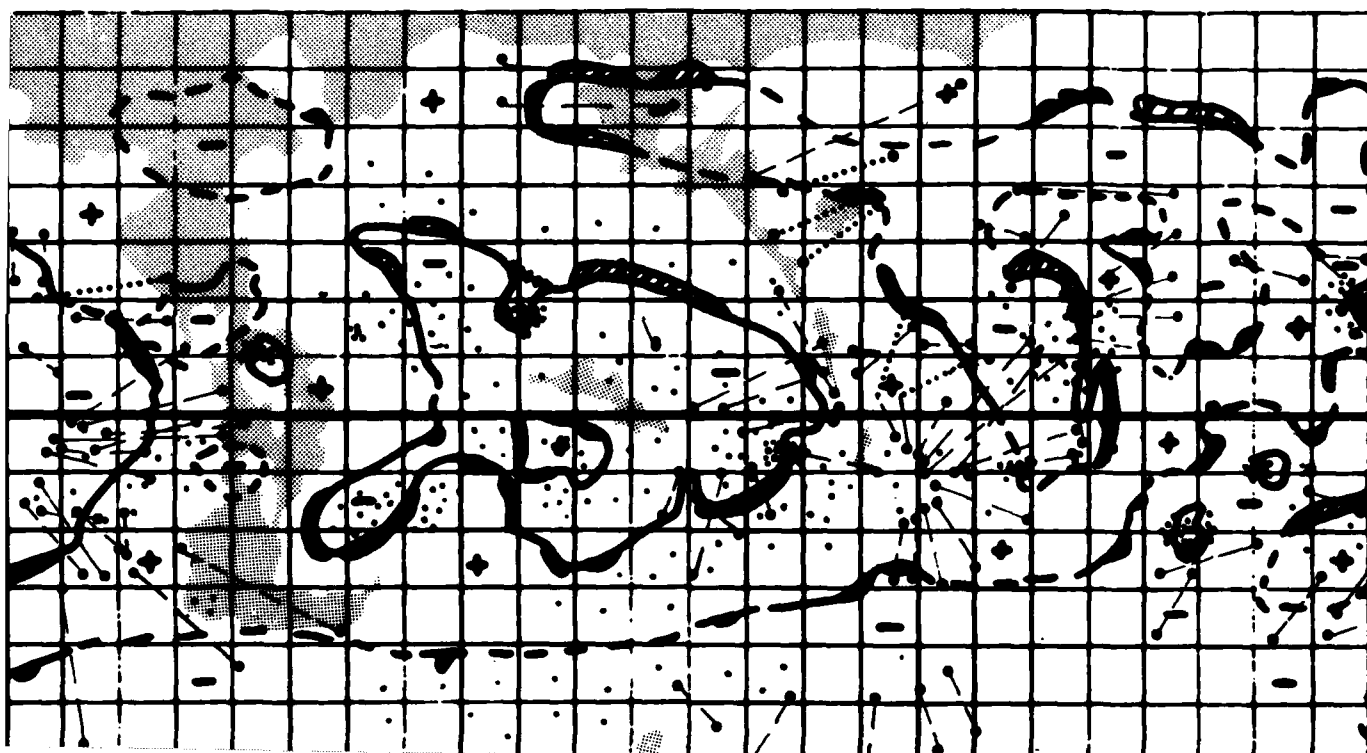
168 167 166 165 164 163 162 161 160 159 158 157 156 155 154 153 152 151

MAY, 1973



208 207 206 205 204 203 202 201 200 199 198 197 196 195 194 193 192 191

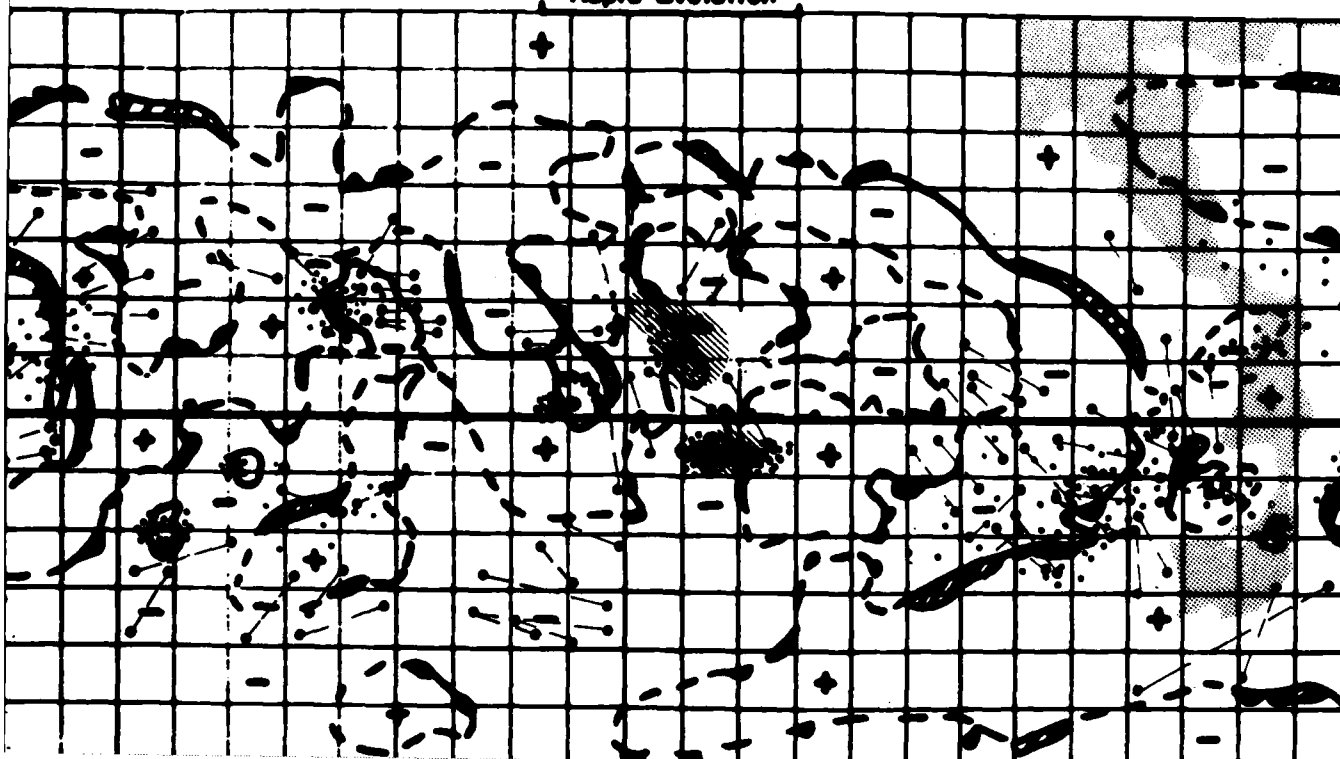
JULY, 1973



195 194 193 192 191 190 189 188 187 186 185 184 183 182 181 180 179 178

Rapid Evolution

JUNE, 1973



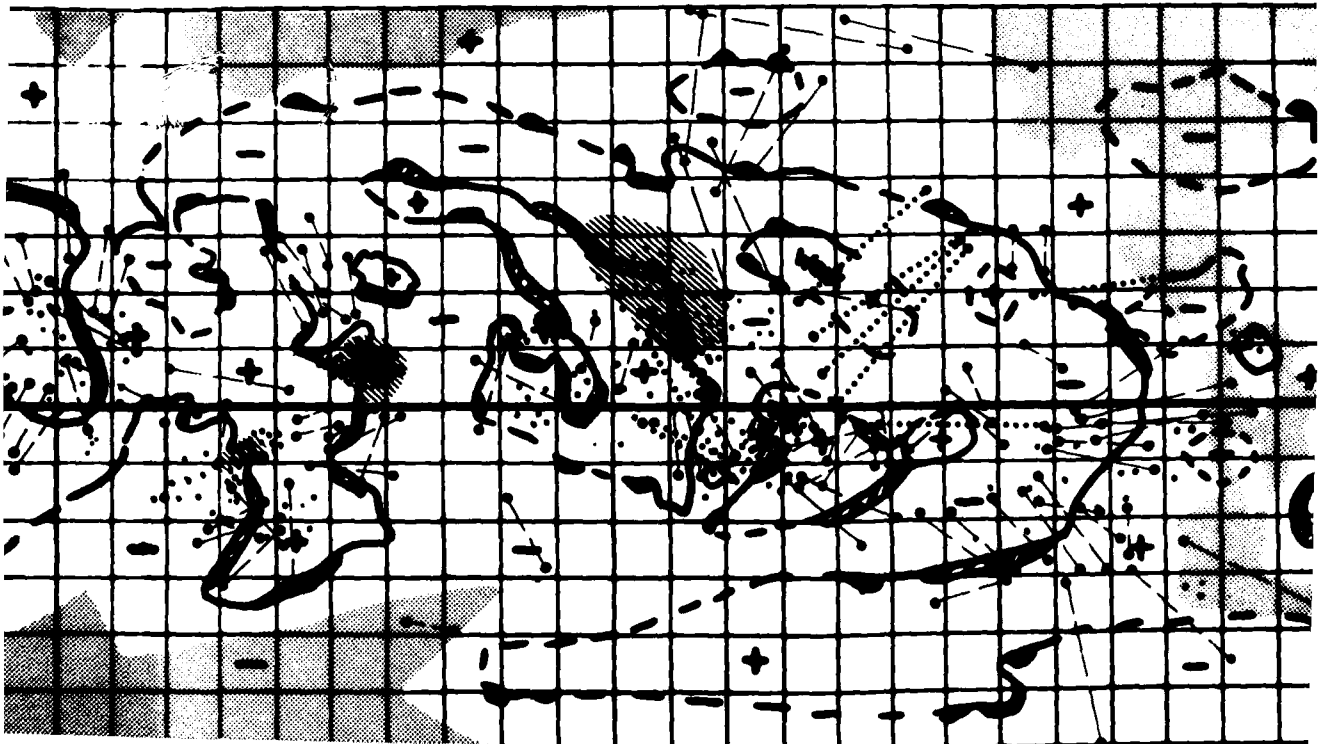
235 234 233 232 231 230 229 228 227 226 225 224 223 222 221 220 219 218

AUGUST, 1973

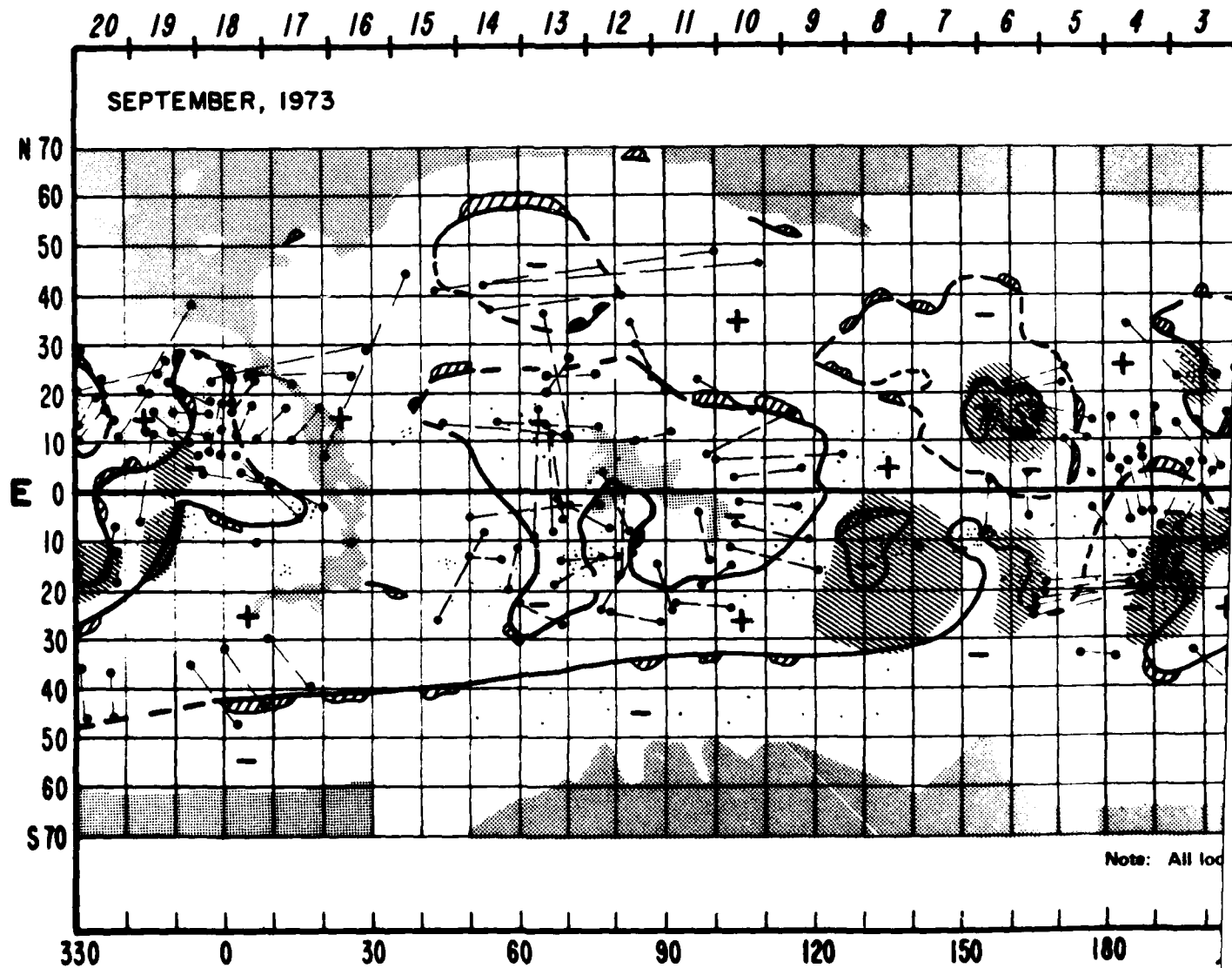


222 221 220 219 218 217 216 215 214 213 212 211 210 209 208 207 206 205

JULY, 1973



H α SYNOPTIC CH 1973 - ROTATION I

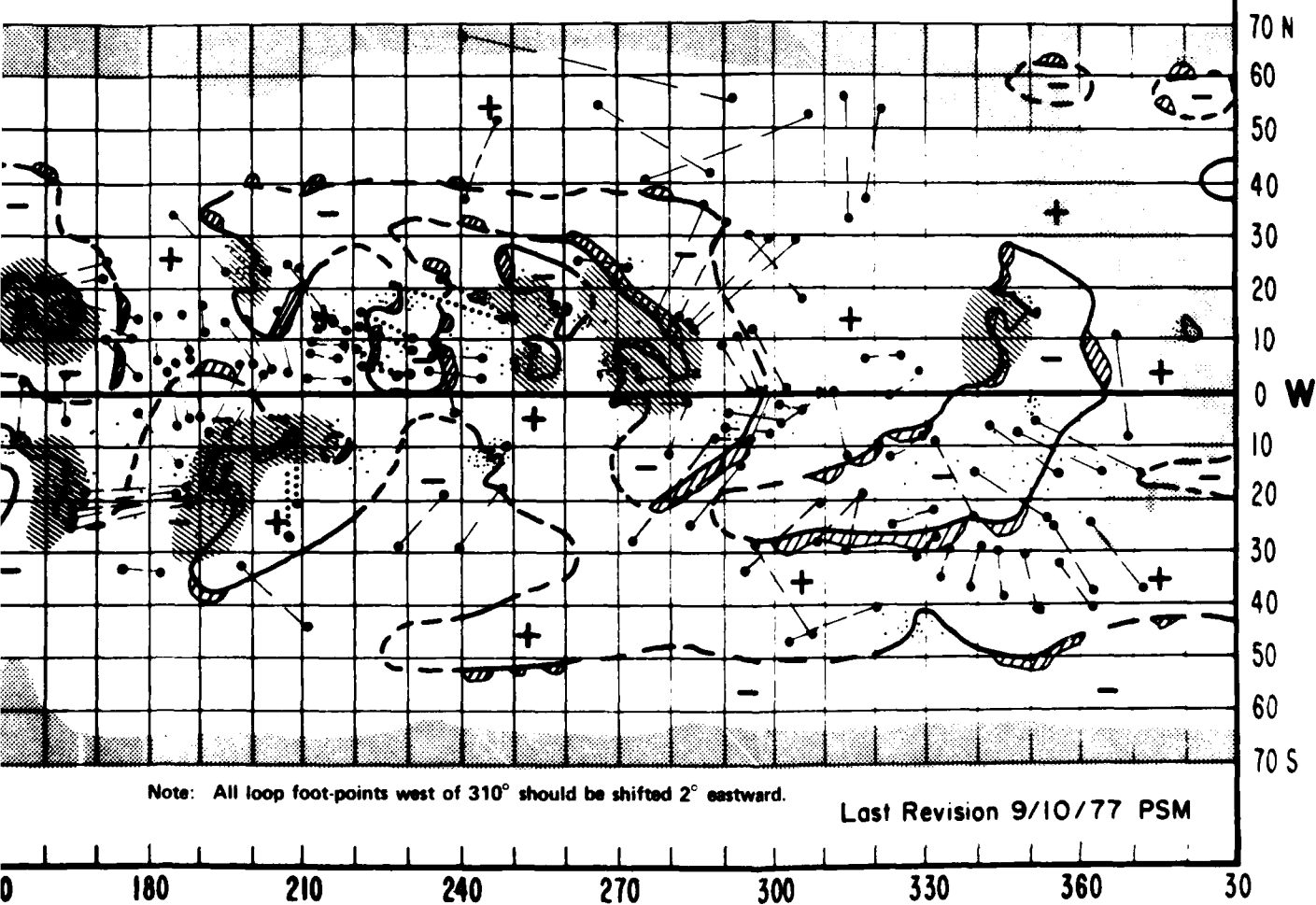


SYNOPTIC CHART

3 - ROTATION 1605

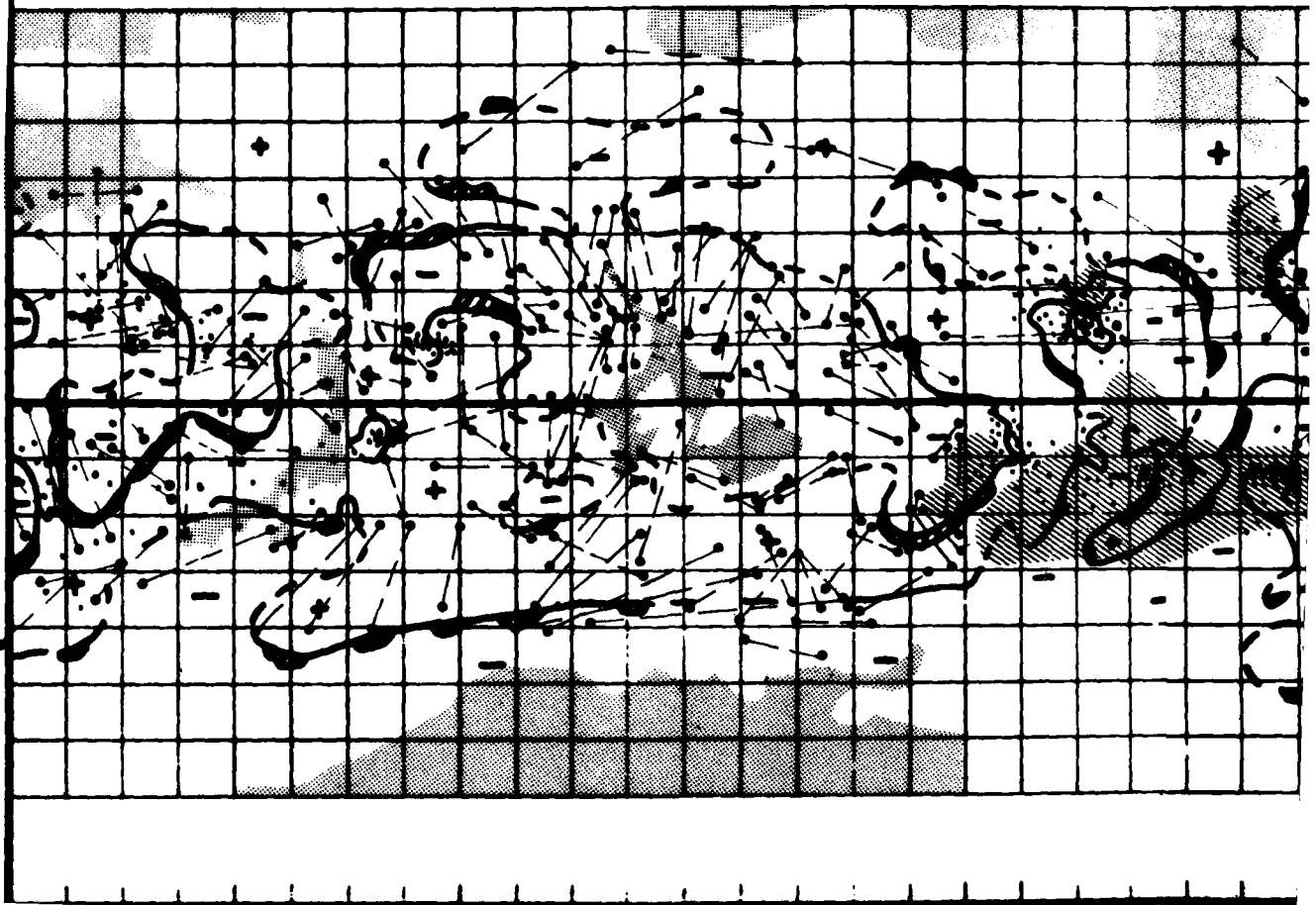
6 5 4 3 2 1 31 30 29 28 27 26 25 24 23 22 21 20

AUGUST, 1973



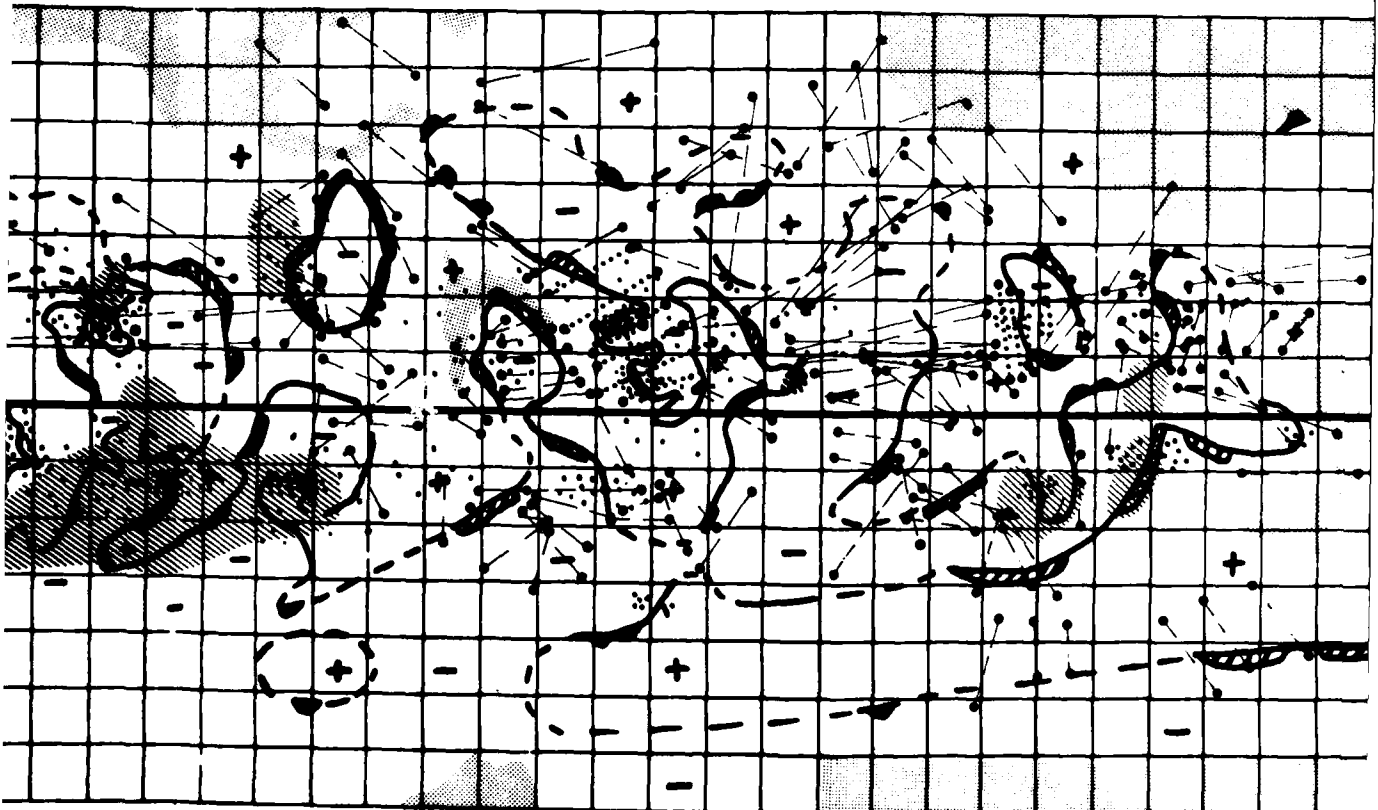
290 289 288 287 286 285 284 283 282 281 280 279 278 277 276 275 274

OCTOBER, 1973

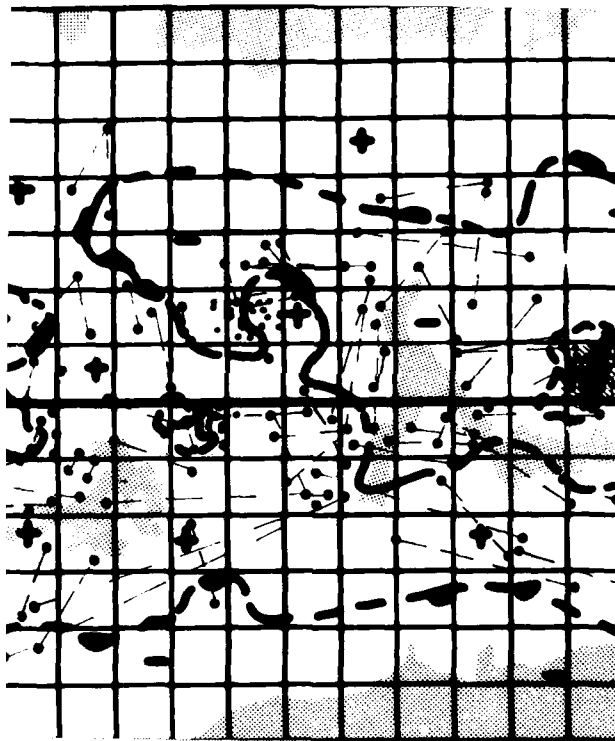


277 276 275 274 273 272 271 270 269 268 267 266 265 264 263 262 261 260

SEPTEMBER, 1973



10/22/74



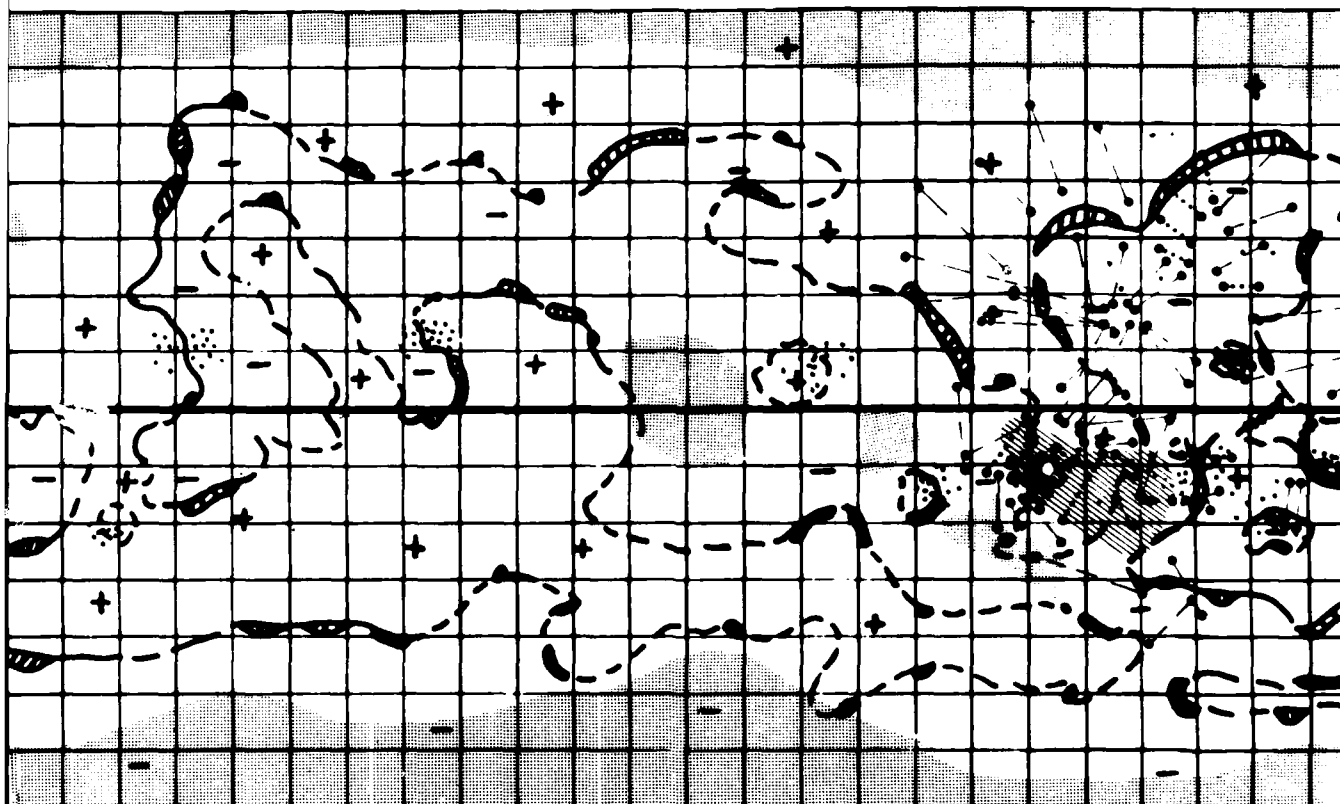
301 300 299 298 297 296 295 294 293 292 291 290 289 288 287

OCTOBER, 1973



345 344 343 342 341 340 339 338 337 336 335 334 333 332 331 330 329 328

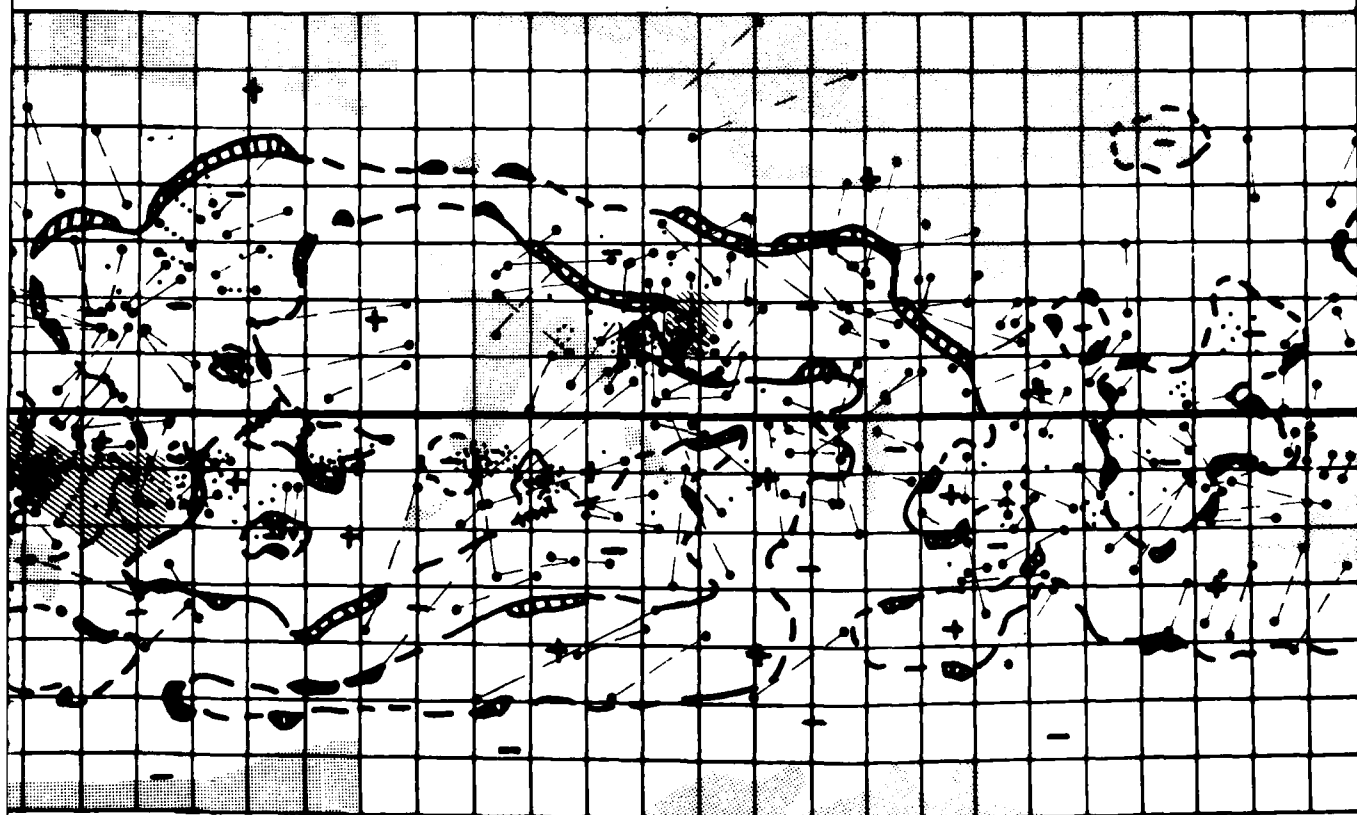
DECEMBER 1973



Note: All loo1

331 330 329 328 327 326 325 324 323 322 321 320 319 318 317 316 315 314

NOVEMBER 1973



Note: All loop foot-points 120° – 350° should be shifted 2° westward.

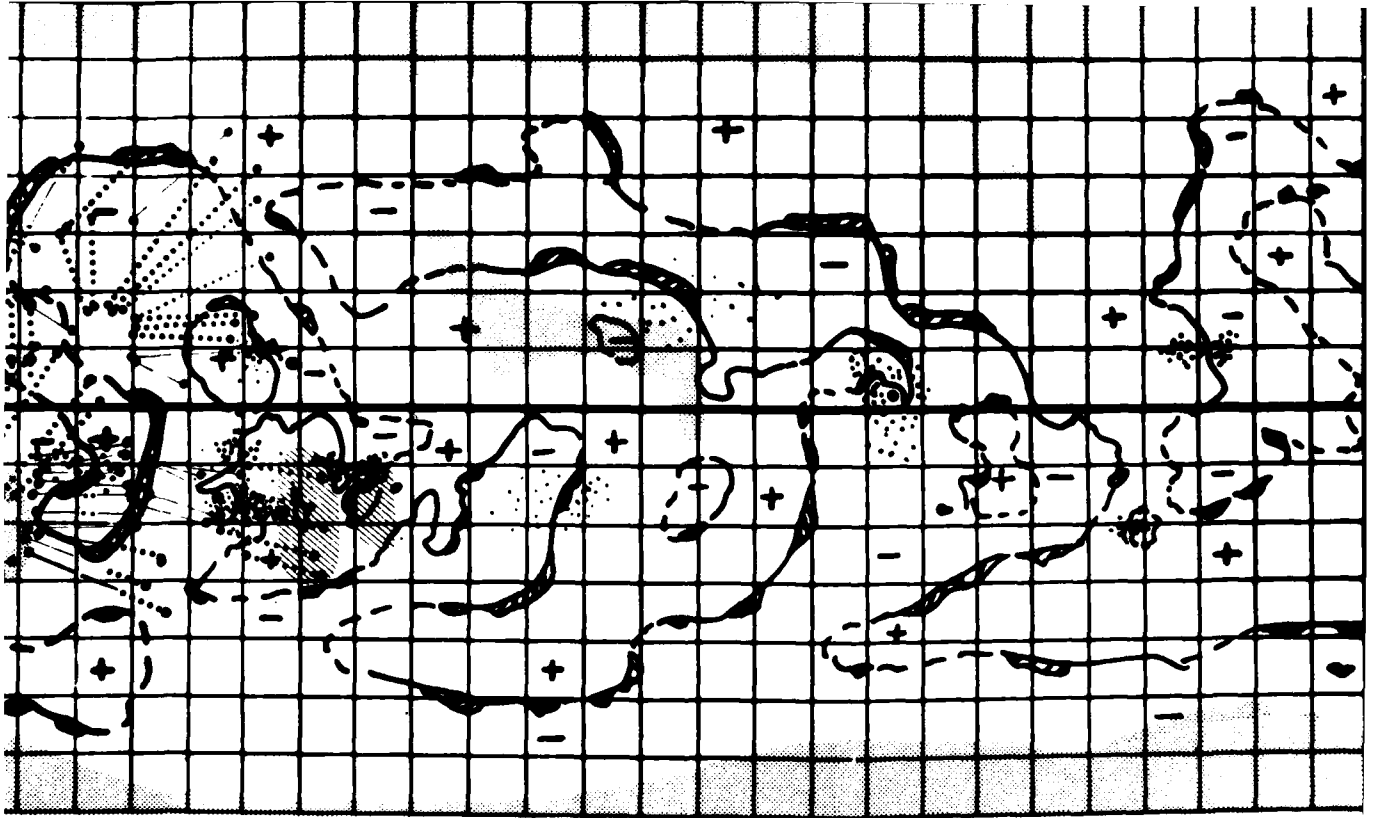
10/15/74

007 006 005 004 003 002 001 365 364 363 362 361 360 359 358 357 356 1

JANUARY, 1974



WEAK AND VARIABLE PATTERNS



10/16/74

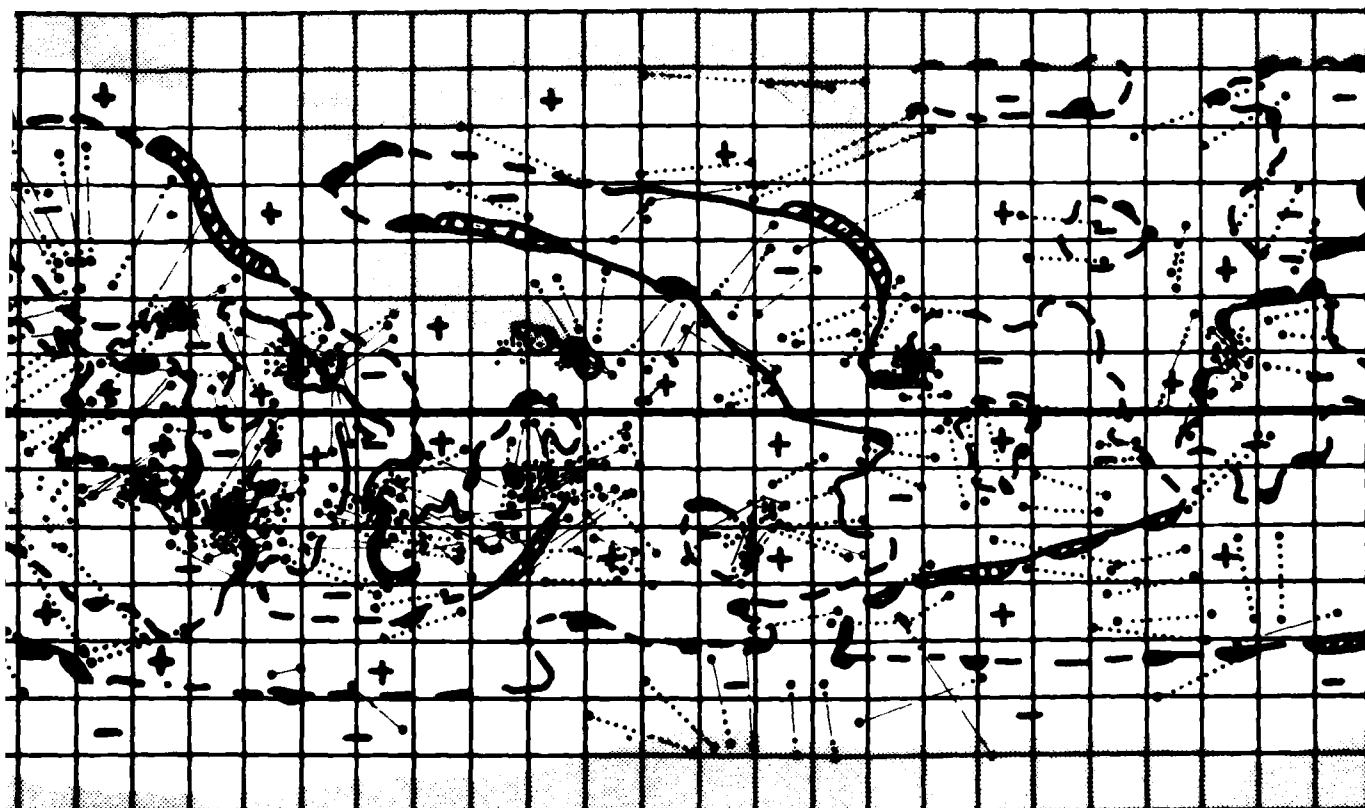
034 033 032 031 030 029 028 027 026 025 024 023 022 021 020 019 018 017

FEBRUARY, 1974



021 020 019 018 017 016 015 014 013 012 011 010 009 008 007 006 005 004

JANUARY, 1974



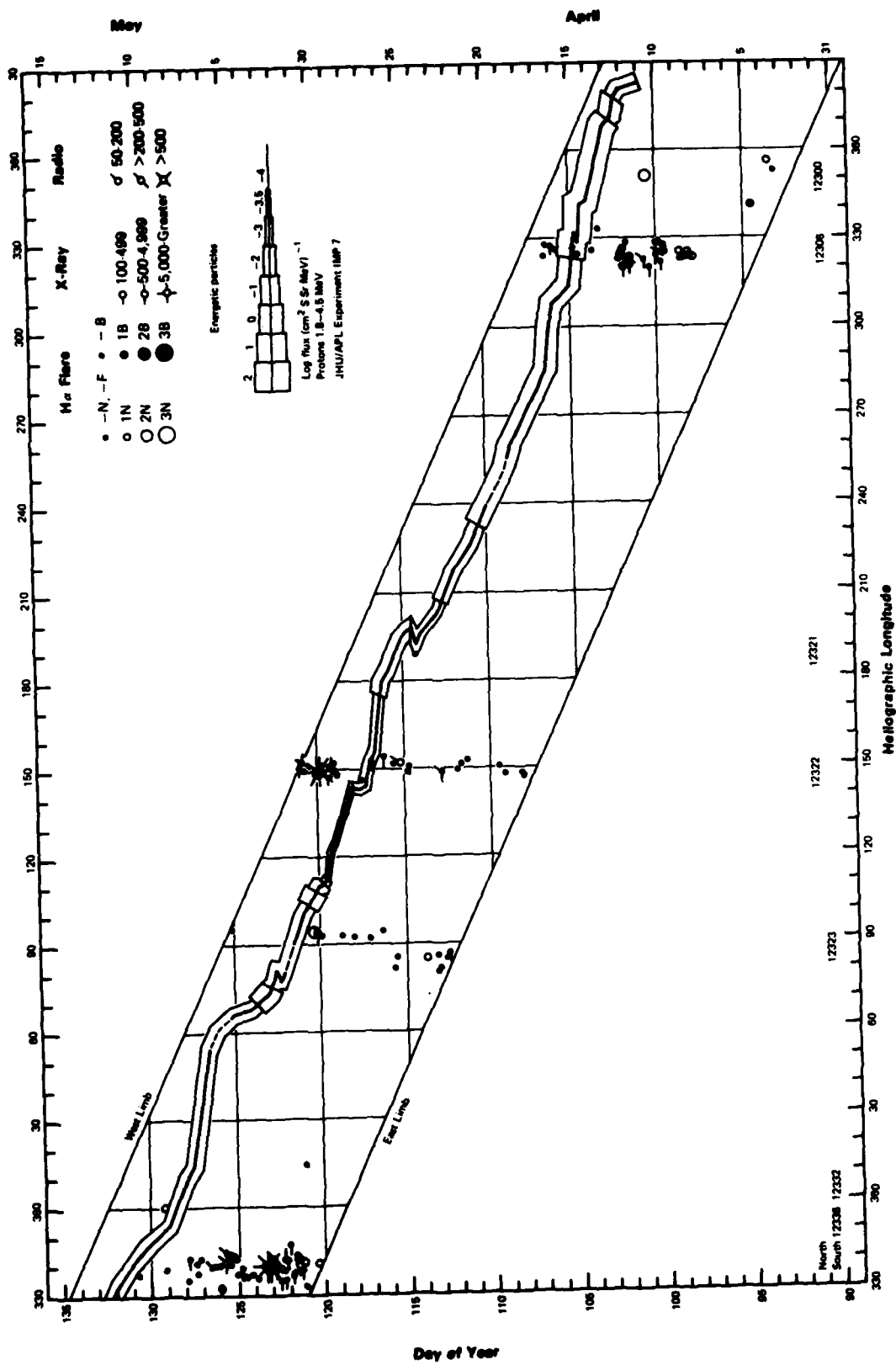
present connections with same resolution as dotted connections on Rotation 1609.

10/20/74

APPENDIX B
Solar Activity Charts, Rotations 1600-1611

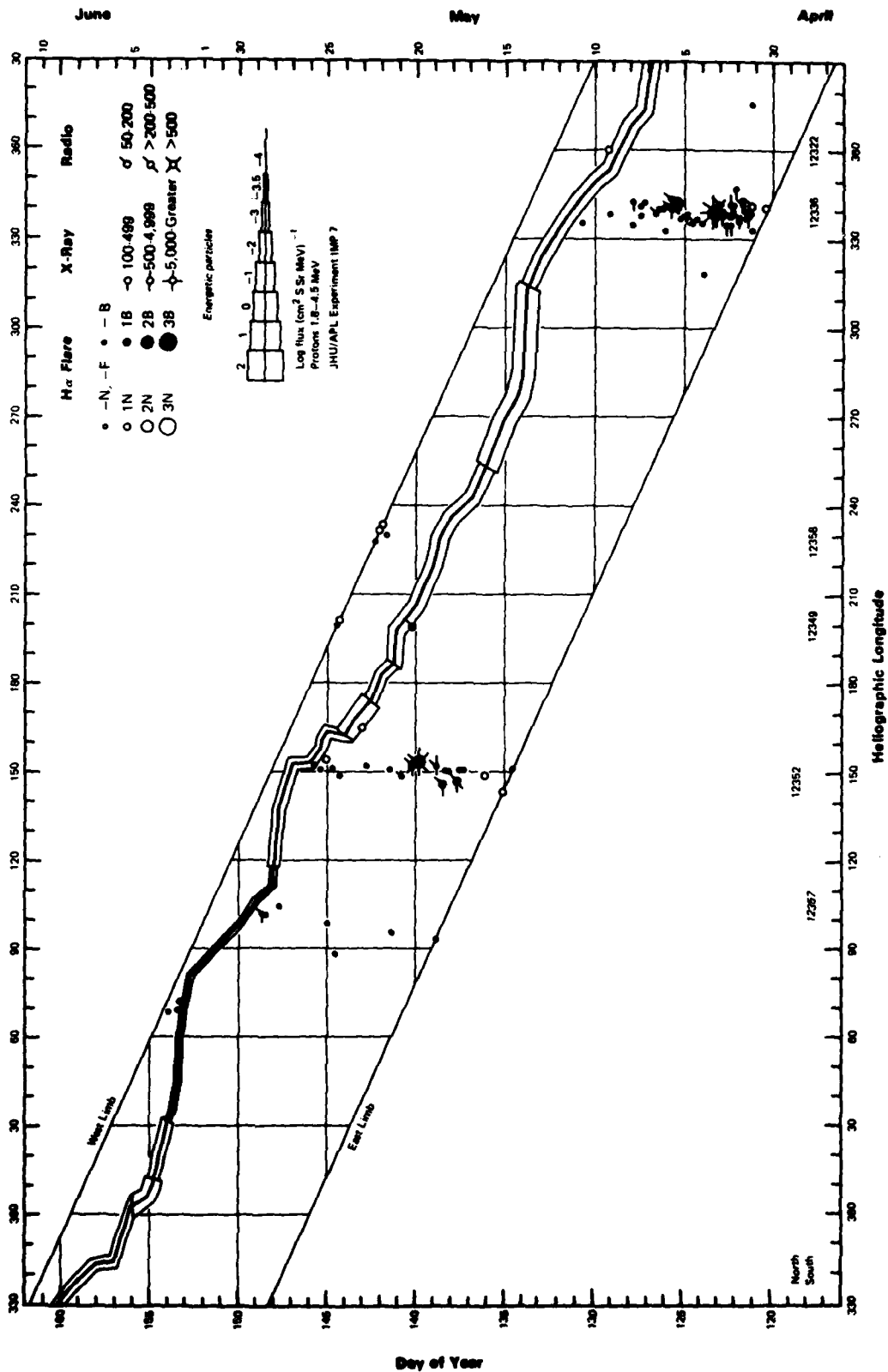
SOLAR ACTIVITY CHART

1973 - ROTATION 1800



SOLAR ACTIVITY CHART

1973 — ROTATION 1801

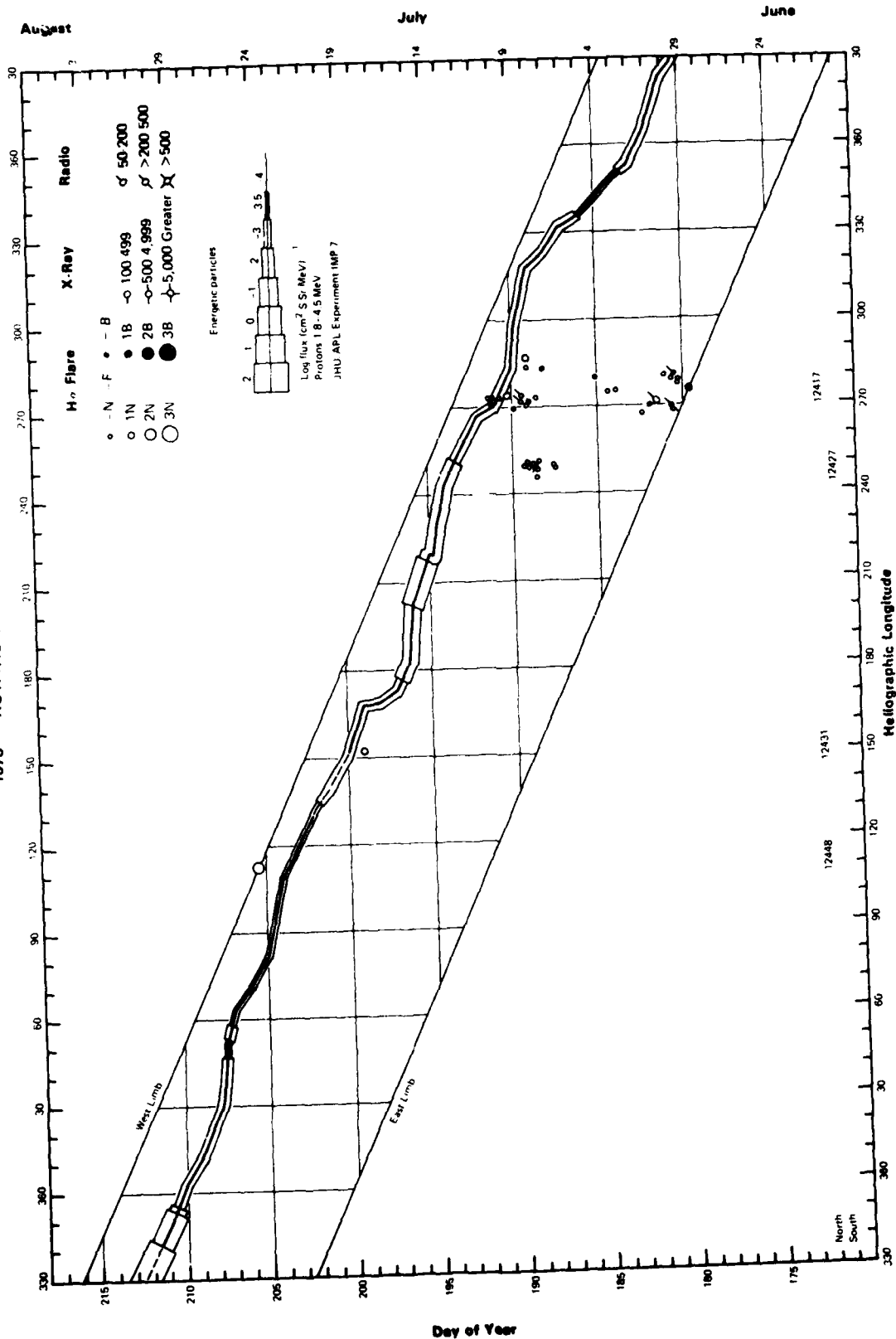


1973 — ROTATION 1602



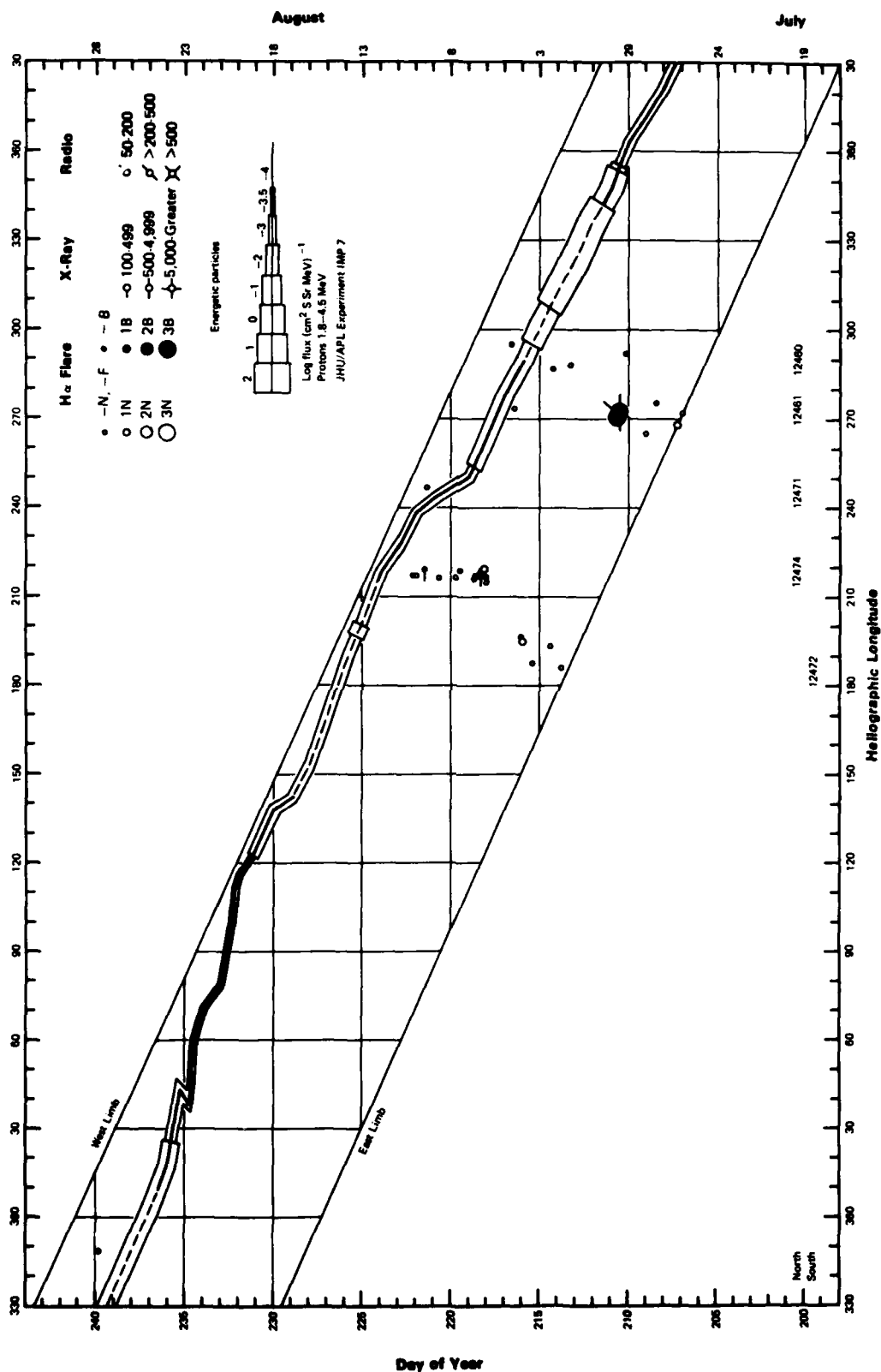
SOLAR ACTIVITY CHART

1973 - ROTATION 1603



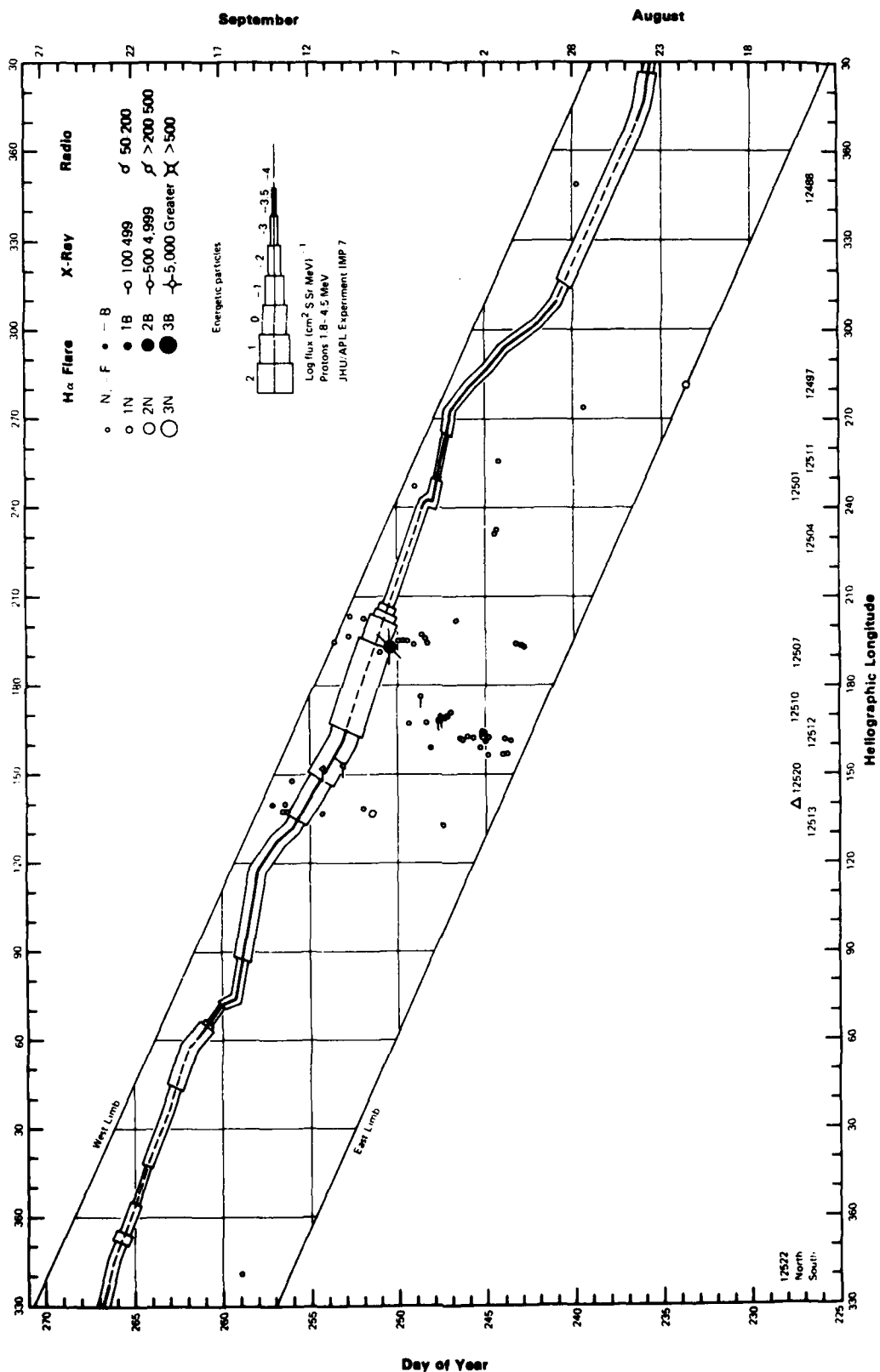
SOLAR ACTIVITY CHART

1973 - ROTATION 1804



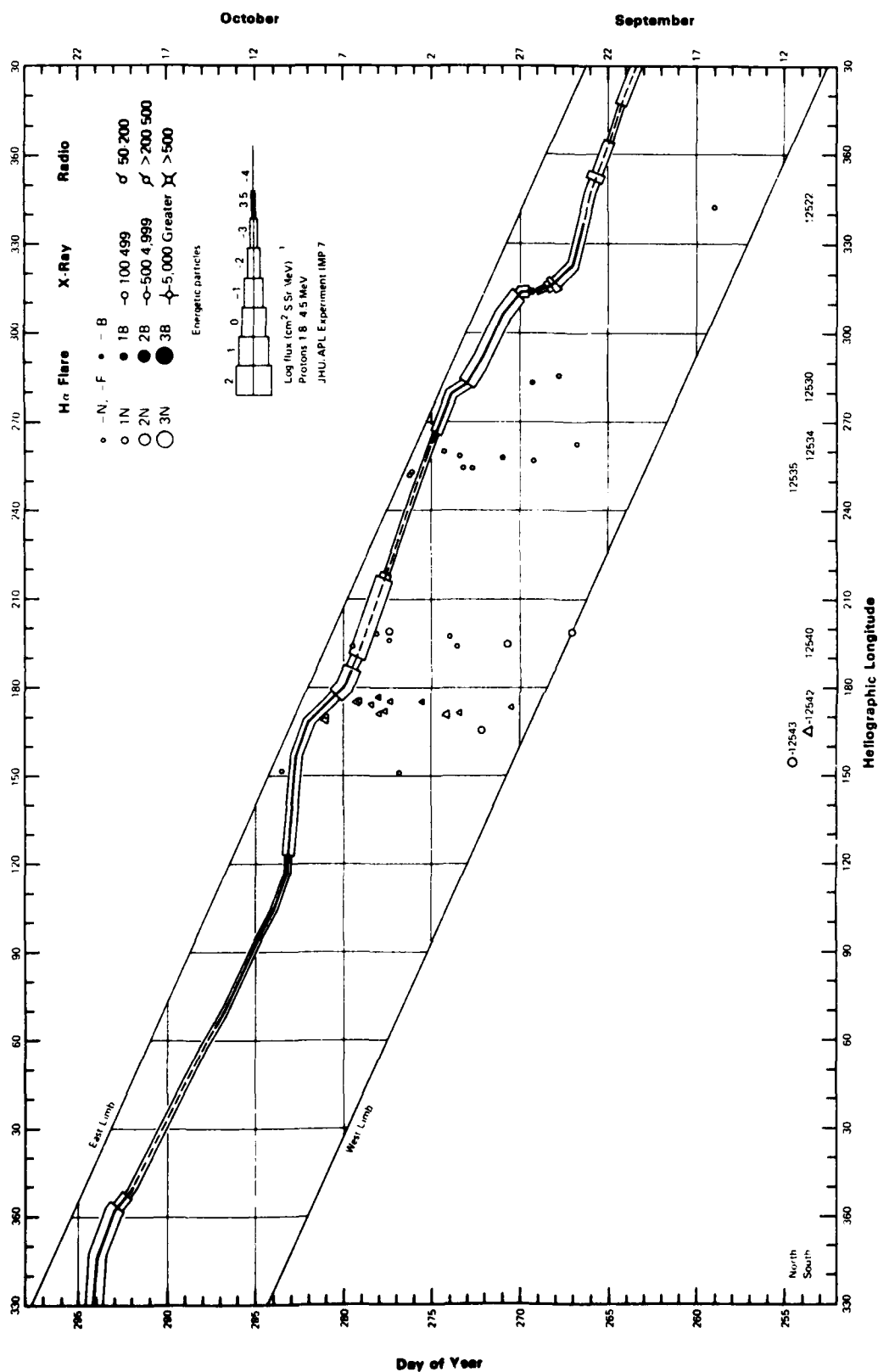
SOLAR ACTIVITY CHART

1973 — ROTATION 1605



SOLAR ACTIVITY UPARI

1973 - ROTATION 1606

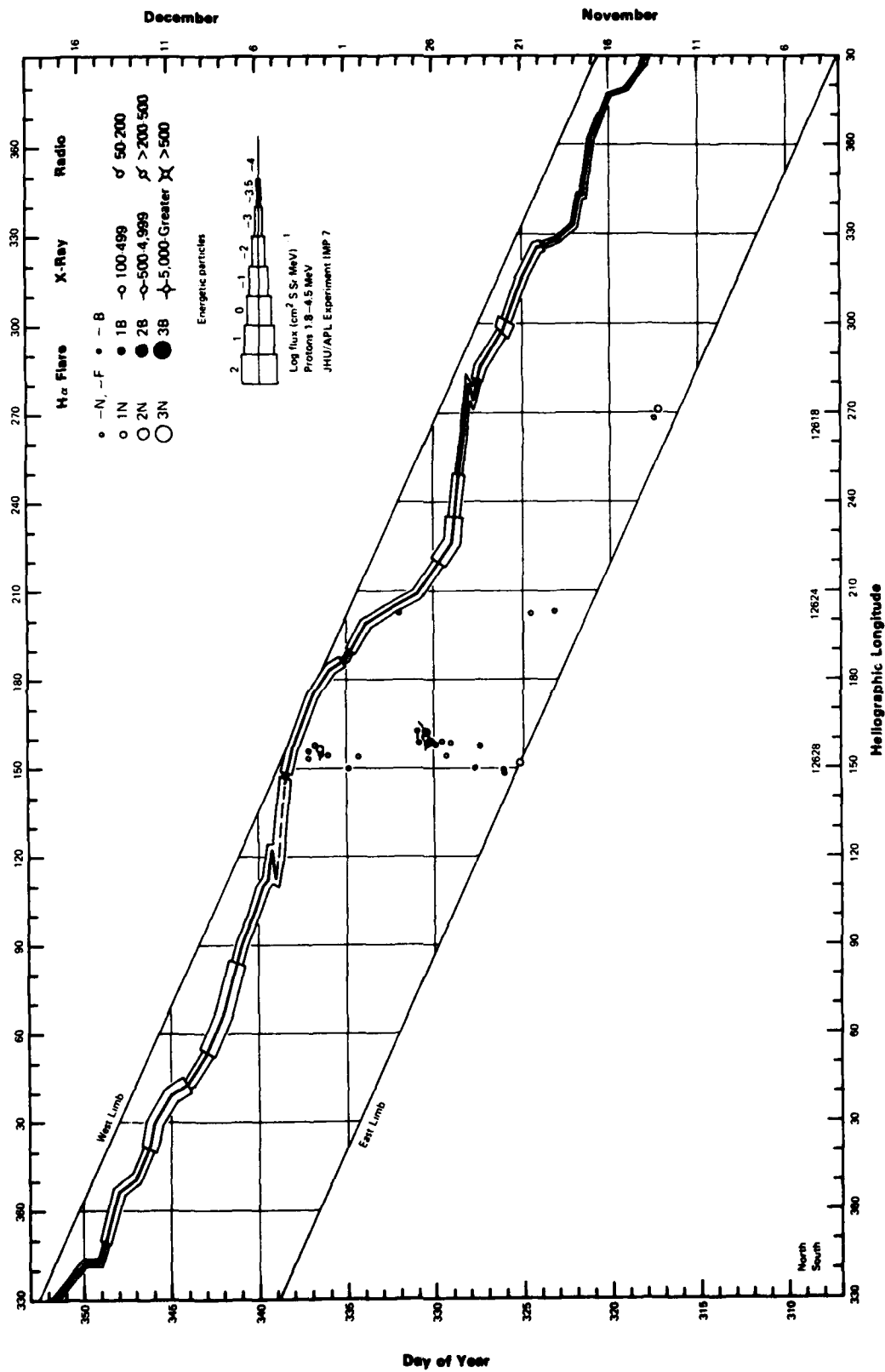


1973 – ROTATION 1607

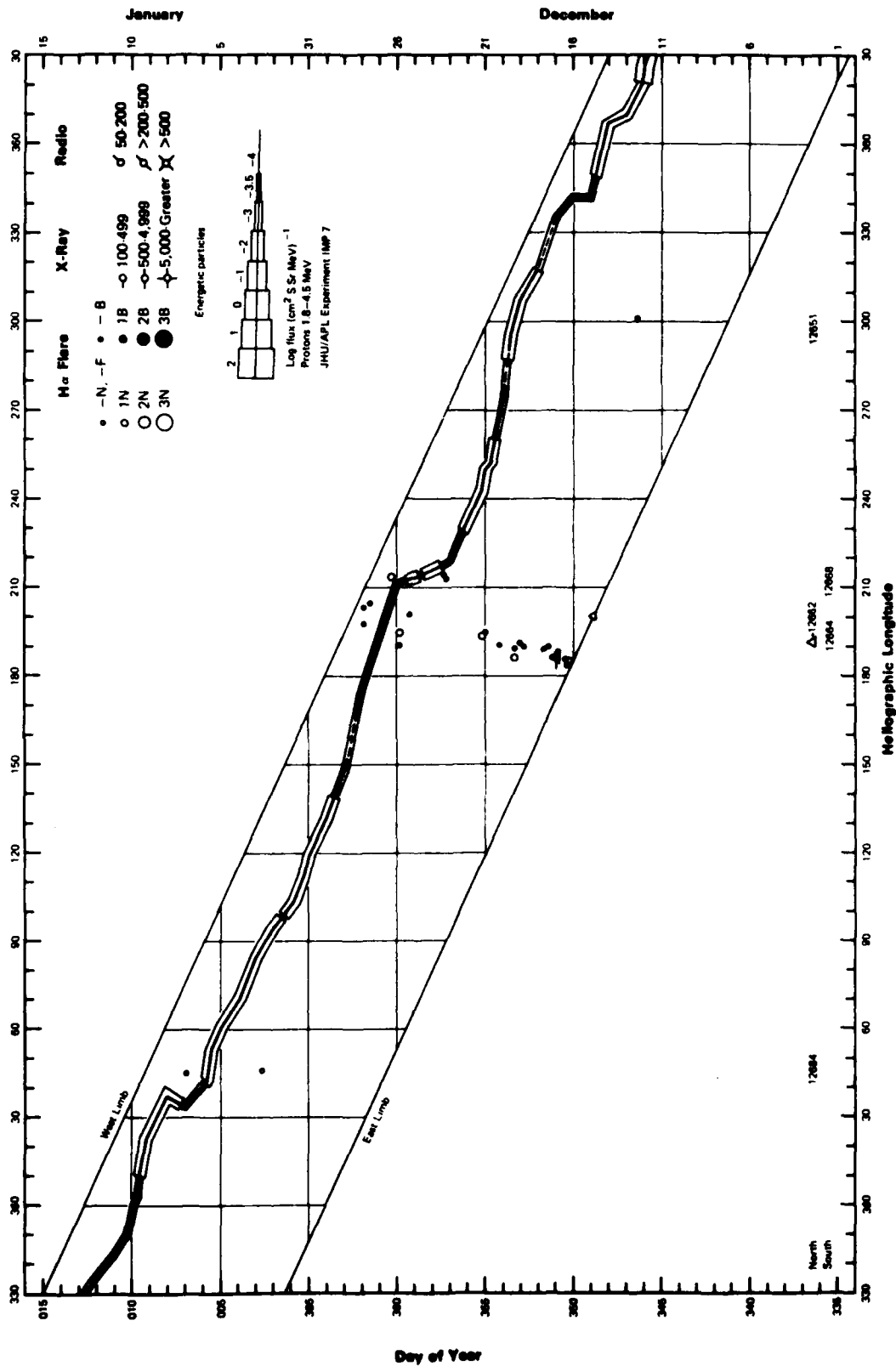


SOLAR ACTIVITY CHARTS

1973 - ROTATION 1608



SOLAR ACTIVITY CHART 1973 - ROTATION 1809



SOLAR ACTIVITY CHARTS

1973-1974 — ROTATION 1610

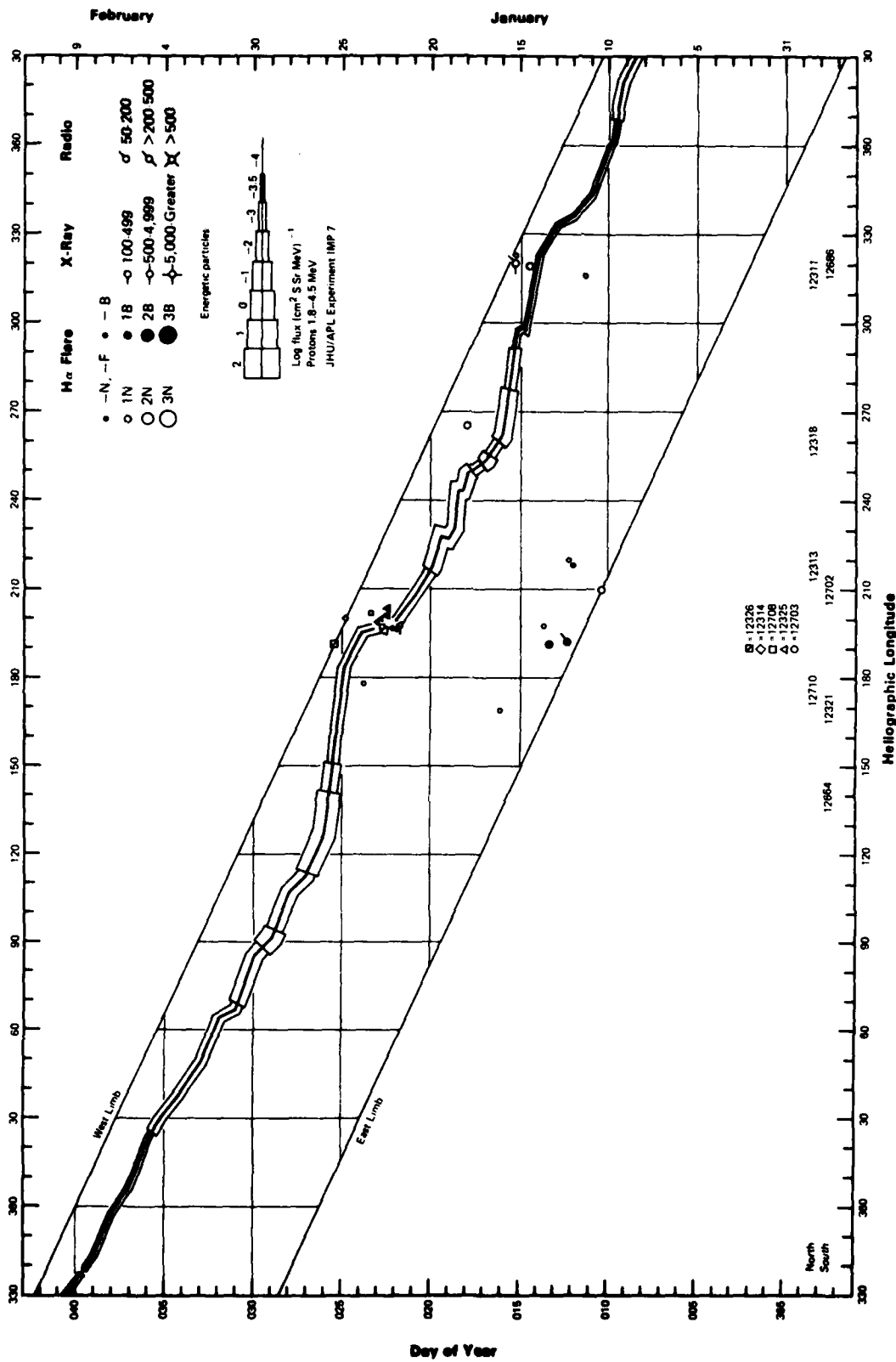
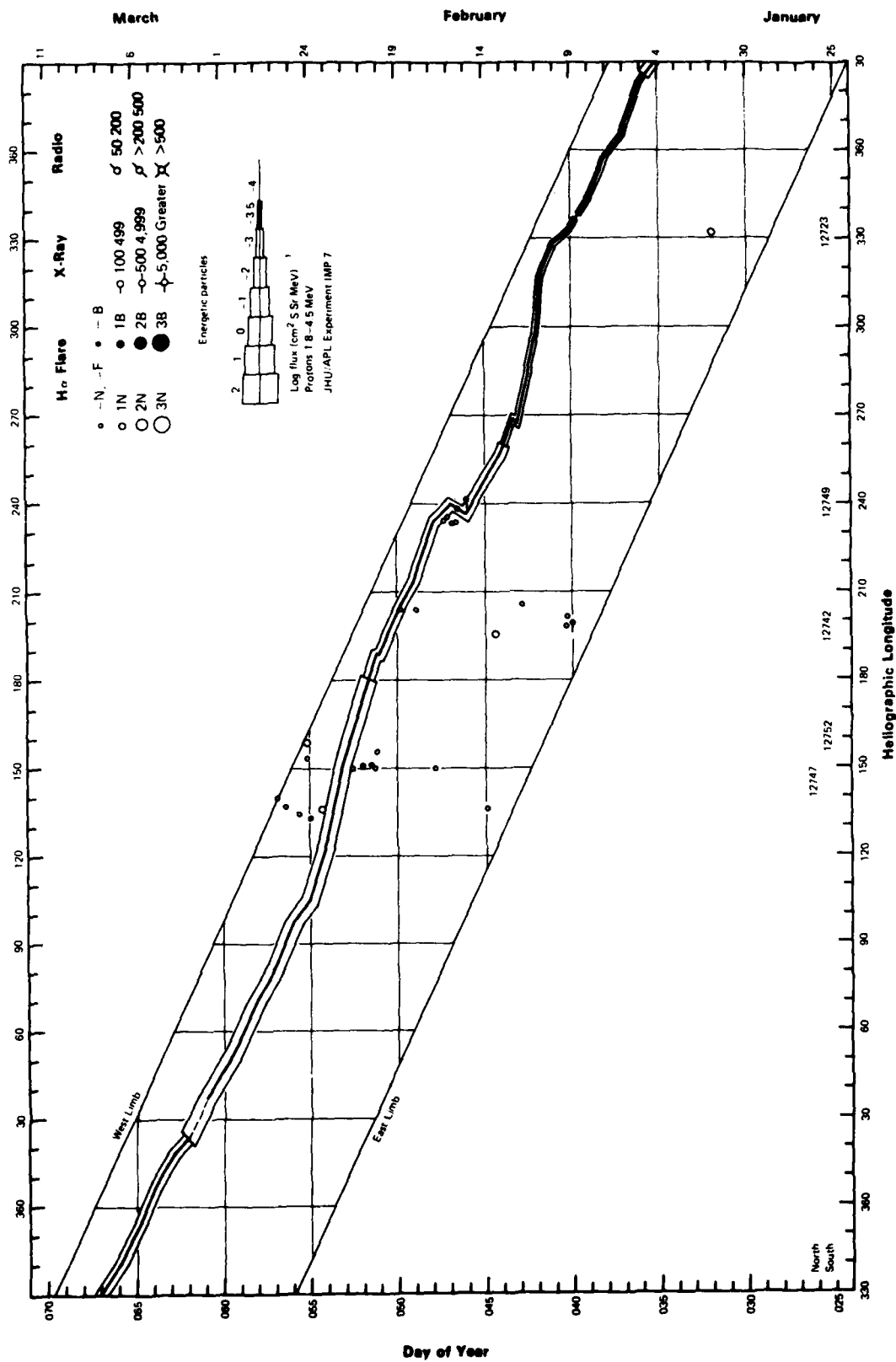


FIGURE 2

SOLAR ACTIVITY CHART

1974 - ROTATION 1611



UAG SERIES OF REPORTS

Between 6 and 12 UAG Reports are published at irregular intervals each year. Subscriptions may be ordered through the National Geophysical and Solar-Terrestrial Data Center, Environmental Data and Information Service, NOAA, Boulder, CO 80303, USA. The annual subscription price is \$25.20 (\$17.30 additional for foreign mailing). Each year the single copy prices total less than \$25.20, the expiration date for all subscriptions will be extended. Back issues may be purchased at the prices shown below plus a \$3.00 handling charge per order; some reports, though, are available only on microfiche. Orders must include check or money order payable in U.S. currency to the Department of Commerce, NOAA/NGSDC.

- UAG-1 "IQSY Night Airglow Data," by L.L. Smith, F.E. Roach, and J.M. McKenna, ESSA Aeronomy Laboratory, Boulder, CO, July 1968, 305 pp, \$1.75.
- UAG-2 "A Reevaluation of Solar Flares, 1964-1966," by Helen W. Dodson and E. Ruth Hedeman, McMath-Hulbert Observatory, University of Michigan, Pontiac, MI, August 1968, 28 pp, \$0.30.
- UAG-3 "Observations of Jupiter's Sporadic Radio Emission in the Range 7.6-41 MHz, 6 July 1966 through 8 September 1968," by James W. Warwick and George A. Dulk, University of Colorado, Boulder, CO, October 1968, 35 pp, \$0.55.
- UAG-4 "Abbreviated Calendar Record 1966-1967," by J. Virginia Lincoln, Hope I. Leighton and Dorothy K. Kropp, ESSA now NOAA, Aeronomy and Space Data Center, Boulder, CO, January 1969, 170 pp, \$1.25.
- UAG-5 "Data on Solar Event of May 23, 1967 and its Geophysical Effects," compiled by J. Virginia Lincoln, World Data Center A, Upper Atmosphere Geophysics, ESSA now NOAA, Boulder, CO, February 1969, 120 pp, \$0.65.
- UAG-6 "International Geophysical Calendars 1957-1969," by A.H. Shapley and J. Virginia Lincoln, ESSA Research Laboratories, now NOAA, Boulder, CO, March 1969, 25 pp, \$0.30.
- UAG-7 "Observations of the Solar Electron Corona: February 1964 - January 1968," by Richard T. Hansen, High Altitude Observatory, NCAR, Boulder, CO, and Kamuela, HI, October 1969, 12 pp, \$0.15.
- UAG-8 "Data on Solar-Geophysical Activity October 24 - November 6, 1968," Parts 1 and 2, compiled by J. Virginia Lincoln, World Data Center A, Upper Atmosphere Geophysics, ESSA now NOAA, Boulder, CO, March 1970, 312 pp, \$1.75 (includes Parts 1 and 2).
- UAG-9 "Data on Cosmic Ray Event of November 18, 1968 and Associated Phenomena," compiled by J. Virginia Lincoln, World Data Center A, Upper Atmosphere Geophysics, ESSA now NOAA, Boulder, CO, April 1970, 109 pp, \$0.55.
- UAG-10 "Atlas of Ionograms," edited by A.H. Shapley, ESSA Research Laboratories now NOAA, Boulder, CO, May 1970, 243 pp, \$1.50.
- UAG-12 "Solar-Geophysical Activity Associated with the Major Geomagnetic Storm of March 8, 1970," Parts 1, 2 and 3, compiled by J. Virginia Lincoln and Dale B. Bucknam, World Data Center A, Upper Atmosphere Geophysics, ESSA now NOAA, Boulder, CO, April 1971, 466 pp, \$3.00 (includes Parts 1-3).
- UAG-13 "Data on the Solar Proton Event of November 2, 1969 through the Geomagnetic Storm of November 8-10, 1969," compiled by Dale B. Bucknam and J. Virginia Lincoln, World Data Center A, Upper Atmosphere Geophysics, ESSA now NOAA, Boulder, CO, May 1971, 76 pp, \$0.90.
- UAG-14 "An Experimental, Comprehensive Flare Index and Its Derivation for 'Major' Flares, 1955-1969," by Helen W. Dodson and E. Ruth Hedeman, McMath-Hulbert Observatory, University of Michigan, Pontiac, MI, July 1971, 25 pp, \$0.30.
- UAG-16 "Temporal Development of the Geophysical Distribution of Auroral Absorption for 30 Substorm Events in each of IQSY (1964-65) and IASY (1960)," by F.T. Berkey, University of Alaska, Fairbanks, AK; V.M. Driatskiy, Arctic and Antarctic Research Institute, Leningrad, USSR; K. Henriksen, Auroral Observatory, Tromsø, Norway; D.H. Jelly, Communications Research Center, Ottawa, Canada; T.I. Shchuka, Arctic and Antarctic Research Institute, Leningrad, USSR; A. Theander, Kiruna Geophysical Observatory, Kiruna, Sweden; and J. Yliniemi, University of Oulu, Oulu, Finland, September 1971, 131 pp, \$0.70 (microfiche only).
- UAG-17 "Ionospheric Drift Velocity Measurements at Jicamarca, Peru (July 1967 - March 1970)," by Ben B. Balsley, NOAA Aeronomy Laboratory, Boulder, CO, and Ronald F. Woodman, Jicamarca Radar Observatory, Instituto Geofísico del Peru, Lima, Peru, October 1971, 45 pp, \$0.55 (microfiche only).
- UAG-18 "A Study of Polar Cap and Auroral Zone Magnetic Variations," by K. Kawasaki and S.-I. Asasofu, University of Alaska, Fairbanks, AK, June 1972, 21 pp, \$0.20.
- UAG-19 "Reevaluation of Solar Flares 1967," by Helen W. Dodson and E. Ruth Hedeman, McMath-Hulbert Observatory, University of Michigan, Pontiac, MI, and Marta Rovira de Miceli, San Miguel Observatory, Argentina, June 1972, 15 pp, \$0.15.
- UAG-21 "Preliminary Compilation of Data for Retrospective World Interval July 26 - August 14, 1972," by J. Virginia Lincoln and Hope I. Leighton, World Data Center A for Solar-Terrestrial Physics, NOAA, Boulder, CO, November 1972, 128 pp, \$0.70.
- UAG-22 "Auroral Electrojet Magnetic Activity Indices (AE) for 1970," by Joe Haskell Allen, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO, November 1972, 146 pp, \$0.75.
- UAG-23 "U.R.S.I. Handbook of Ionogram Interpretation and Reduction," Second Edition, November 1972, edited by W.R. Piggott, Radio and Space Research Station, Slough, UK, and K. Rauer, Arbeitsgruppe für Physikalische Weltraumforschung, Freiburg, GFR, November 1972, 324 pp, \$1.75.
- UAG-23A "U.R.S.I. Handbook of Ionogram Interpretation and Reduction," Second Edition, Revision of Chapters 1-4, edited by W.R. Piggott, Radio and Space Research Station, Slough, UK, and K. Rauer, Arbeitsgruppe für Physikalische Weltraumforschung, Freiburg, GFR, November 1972, 135 pp, \$2.14.
- UAG-24 "Data on Solar-Geophysical Activity Associated with the Major Ground Level Cosmic Ray Events of 24 January and 1 September 1971," Parts 1 and 2, compiled by Helen E. Coffey and J. Virginia Lincoln, World Data Center A for Solar-Terrestrial Physics, NOAA, Boulder, CO, December 1972, 462 pp, \$2.00 (includes Parts 1 and 2).
- UAG-25 "Observations of Jupiter's Sporadic Radio Emission in the Range 7.6-41 MHz, 9 September 1968 through 9 December 1971," by James W. Warwick, George A. Dulk and David G. Swann, University of Colorado, Boulder, CO, February 1973, 35 pp, \$0.35.
- UAG-26 "Data Compilation for the Magnetospherically Quiet Periods February 19-23 and November 29 - December 3, 1970," compiled by Helen E. Coffey and J. Virginia Lincoln, World Data Center A for Solar-Terrestrial Physics, NOAA, Boulder, CO, May 1973, 129 pp, \$0.70.

- UAG-27 "High Speed Streams in the Solar Wind," by D.S. Intriligator, University of Southern California, Los Angeles, CA, June 1973, 16 pp, \$0.15.
- UAG-28 "Collected Data Reports on August 1972 Solar-Terrestrial Events," Parts 1, 2 and 3, edited by Helen E. Coffey, World Data Center A for Solar-Terrestrial Physics, NOAA, Boulder, CO, July 1973, 932 pp, \$4.50.
- UAG-29 "Auroral Electrojet Magnetic Activity Indices AE(11) for 1968," by Joe Haskell Allen, Carl C. Abston and Leslie D. Morris, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO, October 1973, 148 pp, \$0.75.
- UAG-30 "Catalogue of Data on Solar-Terrestrial Physics," prepared by NOAA Environmental Data Service, Boulder, CO, October 1973, \$1.50. Supersedes UAG-11, 15, and 20 catalogs.
- UAG-31 "Auroral Electrojet Magnetic Activity Indices AE(11) for 1969," by Joe Haskell Allen, Carl C. Abston and Leslie D. Morris, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO, February 1974, 142 pp, \$0.75.
- UAG-32 "Synoptic Radio Maps of the Sun at 3.3 mm for the Years 1967-1969," by Earle B. Mayfield, Kennon P. White III, and Fred I. Shimabukuro, Aerospace Corp., El Segundo, CA, April 1974, 26 pp, \$0.35.
- UAG-33 "Auroral Electrojet Magnetic Activity Indices AE(10) for 1967," by Joe Haskell Allen, Carl C. Abston and Leslie D. Morris, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO, May 1974, 142 pp, \$0.75.
- UAG-34 "Absorption Data for the IGY/IGC and IQSY," compiled and edited by A.H. Shapley, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO; W.R. Piggott, Appleton Laboratory, Slough, UK; and K. Rawer, Arbeitsgruppe für Physikalische Weltraumforschung, Freiburg, GFR, June 1974, 381 pp, \$2.00.
- UAG-35 "Catalogue of Digital Geomagnetic Variation Data at World Data Center A for Solar-Terrestrial Physics," prepared by NOAA Environmental Data Service, Boulder, CO, July 1974, 20 pp, \$0.20.
- UAG-36 "An Atlas of Extreme Ultraviolet Flashes of Solar Flares Observed via Sudden Frequency Deviations During the ATM-SKYLAB Missions," by R.F. Donnelly and E.L. Berger, NOAA Space Environment Laboratory, Ft. J.D. Busman, NOAA Commissioned Corps; B. Henson, NASA Marshall Space Flight Center; T.B. Jones, University of Leicester, UK; G.M. Lerfeld, NOAA Wave Propagation Laboratory; K. Majita, University of Hawaii; W.M. Retallack, NOAA Space Environment Laboratory and W.J. Wagner, Sacramento Peak Observatory, October 1974, 95 pp, \$0.55.
- UAG-37 "Auroral Electrojet Magnetic Activity Indices AE(10) for 1966," by Joe Haskell Allen, Carl C. Abston and Leslie D. Morris, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO, December 1974, 142 pp, \$0.75.
- UAG-38 "Master Station List for Solar-Terrestrial Physics Data at WDC-A for Solar-Terrestrial Physics," by R.W. Buhrmann, World Data Center A for Solar-Terrestrial Physics, Boulder, CO; Juan D. Roederer, University of Denver, Denver, CO; and M.A. Shea and D.F. Smart, Air Force Cambridge Research Laboratories, Hanscom AFB, MA, December 1974, 110 pp, \$1.60.
- UAG-39 "Auroral Electrojet Magnetic Activity Indices AE(11) for 1971," by Joe Haskell Allen, Carl W. Abston and Leslie D. Morris, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO, February 1975, 144 pp, \$2.05.
- UAG-40 "H-Alpha Synoptic Charts of Solar Activity for the Period of Skylab Observations, May 1973 - March 1974," by Patrick S. McIntosh, NOAA Space Environment Laboratory, Boulder, CO, February 1975, 32 pp, \$0.56.
- UAG-41 "H-Alpha Synoptic Charts of Solar Activity During the First Year of Solar Cycle 20 October 1964 - August 1965," by Patrick S. McIntosh, NOAA Space Environment Laboratory, Boulder, CO and Jerome T. Nolte, American Science and Engineering, Inc., Cambridge, MA, March 1975, 25 pp, \$0.48.
- UAG-42 "Observations of Jupiter's Sporadic Radio Emission in the Range 7.6-80 MHz, 10 December 1971 through 21 March 1975," by James W. Warwick, George A. Dulk and Anthony C. Riddle, University of Colorado, Boulder, CO, April 1975, 49 pp, \$1.15.
- UAG-43 "Catalog of Observation Times of Ground-Based Skylab-Coordinated Solar Observing Programs," compiled by Helen E. Coffey, World Data Center A for Solar-Terrestrial Physics, NOAA, Boulder, CO, May 1975, 159 pp, \$3.00.
- UAG-44 "Synoptic Maps of Solar 9.1 cm Microwave Emission from June 1962 to August 1973," by Werner Graf and Ronald W. Bracewell, Stanford University, Stanford, CA, May 1975, 183 pp, \$2.55.
- UAG-45 "Auroral Electrojet Magnetic Activity Indices AE(11) for 1972," by Joe Haskell Allen, Carl C. Abston and Leslie D. Morris, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO, May 1975, 144 pp, \$2.10 (microfiche only).
- UAG-46 "Interplanetary Magnetic Field Data 1963-1964," by Joseph H. King, National Space Science Data Center, NASA Goddard Space Flight Center, Greenbelt, MD, June 1975, 382 pp, \$1.95.
- UAG-47 "Auroral Electrojet Magnetic Activity Indices AE(11) for 1973," by Joe Haskell Allen, Carl C. Abston and Leslie D. Morris, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO, June 1975, 144 pp, \$2.10 (microfiche only).
- UAG-48A "Synoptic Observations of the Solar Corona during Carrington Rotations 1580-1596 (11 October 1971 - 15 January 1973)," [Reissue of UAG-48 with quality images], by R.A. Howard, M.J. Koomen, D.J. Michels, R. Fouessey, C.R. Detwiler, D.E. Roberts, R.T. Seal, and J.D. Whitney, U.S. Naval Research Laboratory, Washington, DC, and R.T. Hansen and S.F. Hansen, C.J. Garcia and E. Yesukawa, High Altitude Observatory, NCAR, Boulder, CO, February 1976, 200 pp, \$4.27.
- UAG-49 "Catalog of Standard Geomagnetic Variation Data," prepared by NOAA Environmental Data Service, Boulder, CO, August 1975, 125 pp, \$1.85.
- UAG-50 "High-Latitude Supplement to the URSI Handbook on Ionogram Interpretation and Prediction," edited by W.R. Piggott, British Antarctic Survey, c/o Appleton Laboratory, Slough, UK, October 1975, 294 pp, \$4.00.
- UAG-51 "Synoptic Maps of Solar Coronal Hole Boundaries Derived from He II 304A Spectroheliograms from the Manned Skylab Missions," by J.D. Bohlén and D.M. Rubenstein, U.S. Naval Research Laboratory, Washington, DC, November 1975, 30 pp, \$0.54.
- UAG-52 "Experimental Comprehensive Solar Flare Indices for Certain Flares, 1970-1974," by Helen M. Dodson and E. Ruth Hedeman, McMath-Hulbert Observatory, University of Michigan Pontiac, MI, November 1975, 27 pp, \$0.60.
- UAG-53 "Description and Catalog of Ionospheric F-Region Data, Jicamarca Radio Observatory (November 1966 - April 1969), by W.L. Clark and T.E. Van Zandt, NOAA Astronomy Laboratory, Boulder, CO, and J.P. McClure, University of Texas at Dallas, Dallas, TX, April 1976. 10 pp, \$0.33.

- UAG-54 "Catalog of Ionosphere Vertical Soundings Data," prepared by NOAA Environmental Data Service, Boulder, CO, April 1976, 130 pp, \$2.10.
- UAG-55 "Equivalent Ionospheric Current Representations by a New Method, Illustrated for 8-9 November 1969 Magnetic Disturbances," by Y. Kamide, Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO; H.W. Kroehl, Data Studies Division, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO; M. Kanamitsu, Advanced Study Program, National Center for Atmospheric Research, Boulder, CO; Joe Haskell Allen, Data Studies Division, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO; and S.-I. Akasofu, Geophysical Institute, University of Alaska, Fairbanks, AK, April 1976, 91 pp, \$1.60 (microfiche only).
- UAG-56 "Iso-Intensity Contours of Ground Magnetic H Perturbations for the December 16-18, 1971, Geomagnetic Storm," Y. Kamide, Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO, April 1976, 37 pp, \$1.39.
- UAG-57 "Manual on Ionospheric Absorption Measurements," edited by K. Rawer, Institut für Physikalische Weltraumforschung, Freiburg, GFR, June 1976, 302 pp, \$4.27.
- UAG-58 "ATS-6 Radio Beacon Electron Content Measurements at Boulder, July 1974 - May 1975," by R.B. Fritz, NOAA Space Environment Laboratory, Boulder, CO, September 1976, 61 pp, \$1.04.
- UAG-59 "Auroral Electrojet Magnetic Activity Indices AE(11) for 1974," by Joe Haskell Allen, Carl C. Abston and Leslie D. Morris, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO, December 1976, 144 pp, \$2.16.
- UAG-60 "Geomagnetic Data for January 1976 (AE(7) Indices and Stacked Magnetograms)," by Joe Haskell Allen, Carl C. Abston and Leslie D. Morris, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO, July 1977, 57 pp, \$1.07.
- UAG-61 "Collected Data Reports for STIP Interval II 20 March - 5 May 1976, edited by Helen E. Coffey and John A. McKinnon, World Data Center A for Solar-Terrestrial Physics, Boulder, CO, August 1977, 313 pp, \$2.95.
- UAG-62 "Geomagnetic Data for February 1976 (AE(7) Indices and Stacked Magnetograms)," by Joe Haskell Allen, Carl C. Abston and Leslie D. Morris, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO, September 1977, 55 pp, \$1.11.
- UAG-63 "Geomagnetic Data for March 1976 (AE(7) Indices and Stacked Magnetograms)," by Joe Haskell Allen, Carl C. Abston and Leslie D. Morris, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO, September 1977, 57 pp, \$1.11.
- UAG-64 "Geomagnetic Data for April 1976 (AE(8) Indices and Stacked Magnetograms)," by Joe Haskell Allen, Carl C. Abston and Leslie D. Morris, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO, February 1978, 55 pp, \$1.00.
- UAG-65 "The Information Explosion and Its Consequences for Data Acquisition, Documentation, Processing," by G.K. Hartmann, Max-Planck-Institut für Aeronomie, Lindau, GFR, May 1978, 36 pp, \$0.75.
- UAG-66 "Synoptic Radio Maps of the Sun at 3.3 mm 1970-1973," by Earle B. Mayfield and Fred I. Shimabukuro, Aerospace Corp., El Segundo, CA, May 1978, 30 pp, \$0.75.
- UAG-67 "Ionospheric D-Region Profile Data Base, A Collection of Computer-Accessible Experimental Profiles of the D and Lower E Regions," by L.F. McNamara, Ionospheric Prediction Service, Sydney, Australia, August 1978, 30 pp, \$0.88 (microfiche only).
- UAG-68 "A Comparative Study of Methods of Electron Density Profile Analysis," by L.F. McNamara, Ionospheric Prediction Service, Sydney, Australia, August 1978, 30 pp, \$0.88 (microfiche only).
- UAG-69 "Selected Disturbed D-Region Electron Density Profiles. Their relation to the undisturbed D region," by L.F. McNamara, Ionospheric Prediction Service, Sydney, Australia, October 1978, 50 pp, \$1.29 (microfiche only).
- UAG-70 "Annotated Atlas of the H-alpha Synoptic Charts for Solar Cycle 20 (1964-1974) Carrington Solar Rotations 1487-1616," by Patrick S. McIntosh, NOAA Space Environment Laboratory, Boulder, CO, February 1979, 327 pp, \$3.50.
- UAG-71 "Magnetic Potential Plots over the Northern Hemisphere for 26-28 March 1976," A.D. Richmond, NOAA Space Environment Laboratory, Boulder, CO; H.W. Kroehl, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO; M.A. Henning, Lockheed Missiles and Space Co., Aurora, CO; and Y. Kamide, Kyoto Sangyo University, Kyoto, Japan, April 1979, 118 pp, \$1.50.
- UAG-72 "Energy Release in Solar Flares, Proceedings of the Workshop on Energy Release in Flares, 26 February - 1 March 1979, Cambridge, Massachusetts, U.S.A.," edited by David M. Rust, American Science and Engineering, Inc., Cambridge, MA, and A. Gordon Emslie, Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, July 1979, 68 pp, \$1.50 (microfiche only).
- UAG-73 "Auroral Electrojet Magnetic Activity Indices AE(11-12) for January - June 1975," by J.H. Allen, C.C. Abston, J.E. Salazar and J.A. McKinnon, National Geophysical and Solar-Terrestrial Data Center, NOAA, Boulder, CO, August 1979, 114 pp, \$1.75.
- UAG-74 "ATS-6 Radio Beacon Electron Content Measurements at Ootacamund, India, October - July 1976," by S.O. Bower, K. Davies, R.F. Donnelly, R.N. Grubb, J.E. Jones and J.H. Taylor, NOAA Space Environment Laboratory, Boulder, CO, and R.G. Rastogi, M.R. Deshpande, H. Chandra and G. Sethia, Physical Research Laboratory, Ahmedabad, India, March 1980, 56 pp, \$2.50.
- UAG-75 "The Alaska IMS Meridian Chain: Magnetic Variations for 9 March - 27 April 1978," by H.W. Kroehl and G.P. Kosinski, National Geophysical and Solar-Terrestrial Data Center, Boulder, CO; S.-I. Akasofu, G.J. Romick, C.E. Campbell and G.K. Corrick, University of Alaska, Fairbanks, AK; and C.E. Hornback and A.M. Gray, NOAA Space Environment Laboratory, Boulder, CO, June 1980, 107 pp, \$3.00.
- UAG-76 "Auroral Electrojet Magnetic Activity Indices AE(12) for July - December 1975," by J.H. Allen, C.C. Abston, J.E. Salazar and J.A. McKinnon, National Geophysical and Solar-Terrestrial Data Center, NOAA, Boulder, CO, August 1980, 116 pp, \$2.50.
- UAG-77 "Synoptic Solar Magnetic Field Maps for the Interval Including Carrington Rotations 1601-1680, May 5, 1973 - April 26, 1979," by J. Harvey, B. Gillespie, P. Miedaner and C. Slaughter, Kitt Peak National Observatory, Tucson, AZ, August 1980, 66 pp, \$2.50.
- UAG-78 "The Equatorial Latitude of Auroral Activity During 1972-1977," by W.R. Sheeley, Jr. and R.A. Howard, E. O. Hulbert Center for Space Research, U.S. Naval Research Laboratory, Washington, DC and B.S. Dandekar, Air Force Geophysics Laboratory, Hanscom AFB, MA, October 1980, 61 pp, \$3.00.

END

DATE
FILMED

4-83

DTI